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A Microhabitat Study of Eastern Big Bluestem (*Andropogon gerardii*) Populations: Associated Species and Edaphic Features

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ABSTRACT. *Andropogon gerardii* (big bluestem) is found in remnant populations in the Carolinas. This study focused on microhabitat characteristics of its ecology. Quadrats (1m x 1m; n=362) were sampled from eight *A. gerardii* population sites across the Carolinas for associated species, stem counts and percent cover of *A. gerardii*, and total percent cover of all species. For each population soil samples were collected at random in three quadrats where *A. gerardii* was present and three where it was absent (n=48). A total of 190 associated taxa were identified. *Andropogon gerardii* stem counts were higher in quadrats with either *Lespedeza cuneata*, *Rubus argutus*, *Vitis rotundifolia*, and *Fraxinus* sp. at two or more sites, while *A. gerardii* stem counts were less in quadrats with *Dichanthelium scoparium* for two sites. Soil data across all study sites indicated significantly higher pH and levels of available magnesium, manganese, and boron in quadrats where *A. gerardii* occurred. However, the levels of available copper were higher in quadrats without *A. gerardii*. The total plant cover in quadrats with *A. gerardii* was 73.2% (s.d. 22.6%), compared to 68.5% (s.d. 24.4%) without *A. gerardii*. The clonal growth of *A. gerardii* ramets is best characterized as a "phalanx-like" compared to a "guerrilla-like" foraging strategy.

INTRODUCTION

An understanding of the ecology of rare species is necessary for their management, protection, and enhancement (Brussard 1991). Conservation biologists must be able to characterize the relationships between biotic and environmental conditions for a given species (Schemske et al. 1994). Microhabitat studies are useful in providing information to better understand the influences of both biotic and abiotic factors in rare species ecology (Fowler 1986; Bittner and Gibson 1998; Menges et al. 1999; Tompkins and Stucky 2000; Thompson et al. 2006). The characterization of microhabitat preferences is important in understanding species distributions, abundance, and in determining the factors that threaten the survival of a species (Menges et al. 1999).

Andropogon gerardii Vitman (big bluestem) is a tall, native, C_4, perennial grass. Its range includes all states east of the Rocky Mountains, and it is a major component of the North

American tallgrass prairie (Weaver and Fitzpatrick 1934). It is rare in the Carolinas, where it is primarily found in isolated clumps or in small, remnant prairie communities, primarily in the Piedmont region (Tompkins et al. 2010a; Figure 1). In addition, a large (>5000 culms) population occurs at Buck Creek Serpentine Barren in Clay County, NC in the Blue Ridge physiographic region (Figure 1). Although never as expansive as midwestern prairies, these eastern prairies are thought to have formed pockets interspersed throughout the pre-settlement landscape (Barden 1997; Davis et al. 2002). The original range of *Andropogon gerardii* and other native prairie-like grasses in the Carolinas have been much reduced. This reduction has been primarily attributed to modern land use and fire suppression practices (Barden 1997).

In the Carolinas, *Andropogon gerardii* is best characterized as chronically sparse, occurring over a large geographical range in spite of having a limited number of population sites. In comparison, endemic rare species are distinguished from sparse species by having smaller geographical distributions, and are usually only locally abundant (Rabinowitz et al. 1984). *Andropogon gerardii* populations appear to be less common for the Carolinas than any of the other major prairie-relict grass species (Radford et al. 1968; Tompkins et al. 2010a).

To date, the relationships of associated species and soil factors with *A. gerardii* occurrence for populations in the Carolinas have been largely unexplored. This study focused on describing microhabitat characteristics related to the ecology of *A. gerardii* and its association with other species and soil factors in local populations. These descriptions included the potential identification of factors that may limit or enhance its occurrence in the landscape.

Microhabitat studies have been conducted for midwestern *A. gerardii* populations to better understand their ecology in terms of germination, establishment, resource partitioning, competitive interactions, and spatial abundance (Dwyer 1958; Duralia and Reader 1993; Foster and Gross 1997; Foster 2000; Silletti et al. 2004). These studies have reported that certain associated species may inhibit both the presence and potential biomass production of *A. gerardii*. Few studies of any plant species have looked at microhabitat features across multiple population sites over a broad geographical area, and this is the first for eastern *A. gerardii* populations.

Floristic data from this study will help to identify associated species that could potentially compete with *A. gerardii* populations. These data will also be useful for providing a better understanding of the ecology of these relict prairie communities in the Carolinas, and in their restoration and maintenance.

METHODS

Field-Site Descriptions. Eight *A. gerardii* population sites were selected from various physiographic regions across both North and South Carolina (Figure 1; Table 1). These included the three largest known populations (>0.5 ha; Suther Prairie, Cabarrus County, NC; Buck Creek Serpentine Barren, Clay County, NC; Troy Prairie, Montgomery County, NC), and five smaller populations representing various physiographic regions of the Carolinas. These are among the few known population sites for *A. gerardii* in the Carolinas with >1000 culms. The following is a brief description of each site:

Suther Prairie (SP) is located on private property near SR 2408 (35.45° N, 80.46° W) about 8 km east of Concord in Cabarrus County, North Carolina. It lies along the floodplain of Dutch Buffalo Creek and a portion of the site remains wet for much of the year. The site has the highest quality *A. gerardii* population known for the Carolinas and is among the

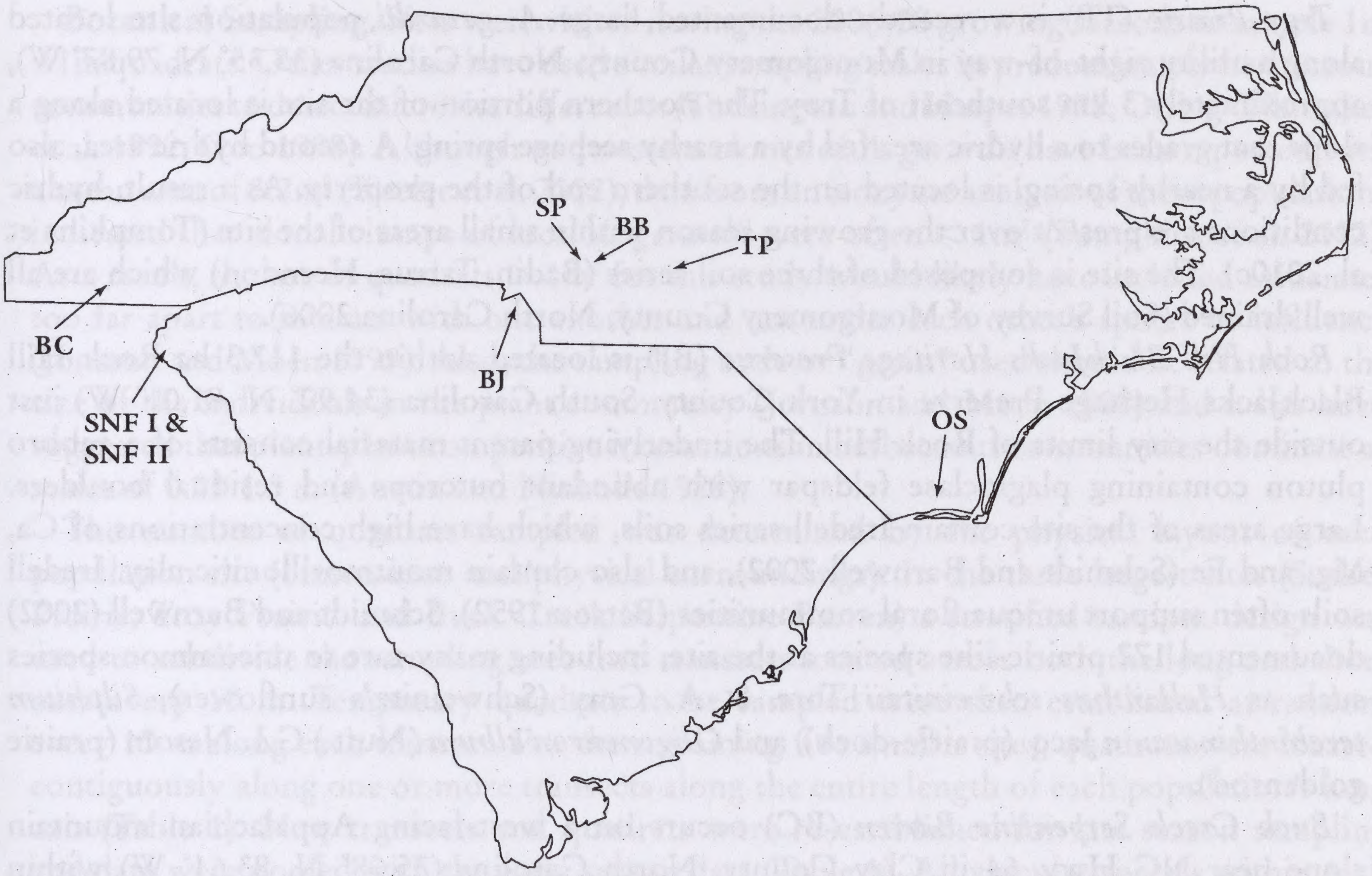

Figure 1. *Andropogon gerardii* study sites in both North and South Carolina. 1 = Suther Prairie (SP), 2 = Bowman Barrier Rd. (BB), 3 = BlackJacks Heritage Preserve (BJ), 4 =Buck Creek Serpentine Barren (BC), 5 = Troy Prairie (TP), 6 = Orton Site (OS), 7 = Sumter National Forest I (SNFI), and 8 = Sumter National Forest II (SNFII).

Table 1. Site descriptions and sampling data from sampled populations of *A. gerardii.*

Population Site	Population Size Area (ha)	Dates Sampled	# of Quadrats Sampled	Quadrats with *A. gerardii*	Percent Quadrats with *A. gerardii*
SP	2.8	5/07; 8/07	45; 45	54	60%
TP	5.0	6/07; 9/07	38; 37	38	51%
BJ	9.0×10^{-3}	5/07; 9/07	38; 37	35	47%
BC	3.0	9/07; 6/08	19; 18	26	70%
OS	4.0×10^{-3}	6/07; 8/08	19; 18	28	76%
BB	0.5	9/06; 6/08	12; 12	10	41%
SNFI	1.2×10^{-3}	7/07; 5/08	6; 6	6	50%
SNFII	2.4×10^{-3}	7/07; 5/08	6; 6	6	50%

SP = Suther Prairie, TP = Troy Prairie, BJ = BlackJacks Heritage Preserve, BC = Buck Creek Serpentine Barren, OS = Orton Site, BB = Bowman Barrier Rd., SNFI and SNFII = Sumter National Forest Sites.

best known examples of a remnant Piedmont prairie (Tompkins et al. 2010b). It is unique in not having been regularly tilled and for its range of mesic to hydric soil conditions. The Chastain soil series for the site is unique with high levels of both Ca and Mg (Tompkins et al. 2010b).

Troy Prairie (TP) is a recently documented, large *A. gerardii* population site located along a utility right-of-way in Montgomery County, North Carolina (35.35° N, 79.87° W), approximately 3 km southeast of Troy. The northern portion of the site is located along a slope that grades to a hydric area fed by a nearby seepage spring. A second hydric area, also fed by a nearby spring, is located on the southern end of the property. As a result, hydric conditions are present over the growing season within small areas of the site (Tompkins et al. 2010c). The site is composed of three soil series (Badin, Tarrus, Herndon) which are all well drained (Soil Survey of Montgomery County, North Carolina 2006).

Rock Hill BlackJacks Heritage Preserve (BJ) is located within the 117.3 ha Rock Hill BlackJacks Heritage Preserve in York County, South Carolina (34.90° N, 81.01° W) just outside the city limits of Rock Hill. The underlying parent material consists of a gabbro pluton containing plagioclase feldspar with abundant outcrops and residual boulders. Large areas of the site contain Iredell series soils, which have high concentrations of Ca, Mg, and Fe (Schmidt and Barnwell 2002), and also contain montmorillonitic clay. Iredell soils often support unique floral communities (Batson 1952). Schmidt and Barnwell (2002) documented 172 prairie-like species at the site, including many rare to uncommon species such as *Helianthus schweinitzii* Torr. & A. Gray (Schweinitz's sunflower), *Silphium terebinthinaceum* Jacq. (prairie-dock), and *Oligoneuron album* (Nutt.) G.L.Nesom (prairie goldenrod).

Buck Creek Serpentine Barren (BC) occurs on a west-facing Appalachian mountain slope near NC Hwy. 64 in Clay County, North Carolina (35.08° N, 83.61° W) within Nantahala National Forest. Its geology is unique, comprising a peridotite outcrop that is approximately 90% olivine and serpentinized dunite (Mansberg and Wentworth 1984). It contains a Eutrochrept soil (Soil Survey of Clay County, North Carolina 1998). According to Kauffman et al. (2004) this site is the most floristically distinctive serpentine area in the southern Appalachians. It has remained undisturbed since 1932 when it was acquired by the U.S. Forest Service, after being mined from 1875 to 1906 for corundum (Mansberg 1981; Mansberg and Wentworth 1984).

Orton Site (OS) is located off the right shoulder of SR 133 N in Brunswick County, North Carolina (34.07° N, 77.95° W), approximately 3 km from Orton. It is restricted to the road backslope and is the easternmost site in the study. It was the only site in the study located in the coastal plain region. The soil for the site is alluvium with the sandy loam Baymeade soil series (Soil Survey of Brunswick County, North Carolina 1986).

Bowman Barrier Road (BB) in Cabarrus County, North Carolina (35.38° N, 80.42° W) is located near SR 2610 about 3 km southeast of Mt. Pleasant. It lies within a floodplain along Dutch Buffalo Creek approximately 15 km downstream from the Suther Prairie site. The Chewacla soil series for the site is poorly drained (Soil Survey of Cabarrus County, North Carolina 1988). The site also has a history of agricultural use.

Sumter National Forest Site I (SNFI) occurs along the shoulder of Battle Creek Rd. in Oconee County, South Carolina in Sumter National Forest (34.76° N, 83.27° W) about 3.25 km west of the Long Creek Community. This was the smallest site in the study. The Madison soil series for the site is well drained (Natural Resources Conservation Service 2009).

Sumter National Forest Site II (SNFII) is also located within Sumter National Forest (34.75° N, 83.27° W) along Damascus Church Rd. This site is approximately 3 km from the previous site located off the edge of the road. This site is also comprised of the Madison soil series (Natural Resources Conservation Service 2009).

Botanical Sampling. Sites were visited during the 2006-08 growing seasons to sample 1m x 1m quadrats. Other studies have used similar sampling scales in predominately herbaceous communities to detect microsite differences (Turkington and Harper 1979; Olsivg-Whittaker et al. 1992; Guo 1998). Although midwestern clones of *A. gerardii* have been reported with a mean area of 3.2m^2 (Keeler et al. 2002), data from an isozyme analysis of these populations indicated that clonal clumps of local *A. gerardii* were often $<$ 1m^2 (Tompkins et al. 2012). As a result, the use of quadrats $>$ 1m^2 for this study would likely have included associates too far apart to interact with one another and not under each other's sphere of influence (Jonsson and Moen 1998). Also, the sampling scale or "grain" used should be related to the size of the individuals in the plant community (Jonsson and Moen 1998) and it has been suggested that plant-plant competitive interactions in herbaceous communities dominate at scales of 0.25-1.5 m (Austin and Nicholls 1988).

The number of quadrats sampled was determined by the physical layout of each population site (dimensions and/physical surroundings). In the three largest sites (Suther Prairie, Troy Prairie, and Buck Creek Serpentine Barren) a stratified random design was used to subdivide the sampling area into transects located across both the long and short axes every 10 m. Temporary quadrats to be sampled were then established at random every 10 m along each transect. For the remaining five smaller sites, quadrats were located contiguously along one or more transects along the entire length of each population's long axis (Table 1). New transects and quadrats were re-established for late season sampling and data were pooled with the early season data (Table 1). All vascular species within each quadrat were identified and total stem counts made for *A. gerardii.* In addition, the total percent plant cover combined for all associated species, as well as the total percent cover of *A. gerardii,* were estimated for each quadrat based on the following cover classes: 5 = 80-100%, 4 = 60-79%, 3 = 40-59%, 2 = 20-39%, 1 = <20% (Daubenmire modified; Mueller-Dombois and Ellenberg 1974). Voucher specimens were stored in the herbaria of Clemson University and Belmont Abbey College. Botanical nomenclature follows Weakley (2007).

Unpaired t-tests were used to compare the mean of *A. gerardii* stem counts (density) in the sampled quadrats where an associated species was present to the mean of *A. gerardii* stem counts (density) in the sampled quadrats where an associated species was not present. T-tests were not performed on associates that occurred in $<$ 5% of the quadrats across the study sites. Assumptions for the t-tests such as independent errors, homogeneous error variance between groups, and normal distribution of errors were assessed with the Durbin-Watson, Levene's, and Shapiro-Wilk Tests, respectively, and found to be satisfied. A significant difference in the mean stem counts ($p < 0.05$) was taken as evidence of an association between *A. gerardii* and the associated species. Since there were many possible species to associate with *A. gerardii* in each of the sites, the associations were tested using a sequential Bonferroni procedure (Rice 1989) to avoid possible false positive associations (Type I Error) and to avoid missing a potentially important association (Type II Error). A t-test was also performed on the total percent cover within each quadrat with and without the presence of *A. gerardii.* All statistical analyses were performed with SAS version 9.1 (SAS Institute 2002).

Soil Sampling. Soil samples were collected at random for each site in three quadrats (n=24) where *A. gerardii* individuals were present. For comparison, samples were also collected from quadrats where *A. gerardii* was absent (n=24) for each site. To provide more accurate information on soil nutrient levels of varying depths, 10 cm soil samples were extracted with a soil corer at three depths (0-10 cm, 11-20 cm, 21-30 cm) for each of the quadrats sampled and analyzed separately for each depth. Due to the relative uniformity of the soil values measured for all three depths, the soil feature values were averaged for all three depths for each site. Soil samples were analyzed by the Clemson University Agricultural Service Laboratory for the following soil features: pH; % organic carbon and nitrogen; extractable phosphorus, potassium, calcium, magnesium, copper, boron, zinc, manganese; and cation exchange capacity (CEC). Mineral analyses were performed using Mehlich No. 1 extraction solution and element quantification by inductively coupled plasma emission spectroscopy (ICP-AES) (Jones 2001). Due to the fact that most Piedmont prairie sites have dry to xeric soil conditions, moisture levels were not measured for the sampled quadrats (Schafale and Weakley 1990).

An ANOVA was performed for all 12 soil features to determine if the values differed in quadrats with or without *A. gerardii* present. Assumptions for the ANOVA such as independent errors, homogeneous error variance between groups, and normal distribution of errors were assessed with the Durbin-Watson, Levene's, and Shapiro-Wilk Tests, respectively, and found to be satisfied. Because the effect of site on the soil features could confound or mask the differences between quadrats with and without *A. gerardii*, two approaches were used. One approach was to include site as a blocking factor in an ANOVA allowing for overall comparisons. The second approach was to compare quadrats with and without *A. gerardii* for each individual site to allow for specific effects that may have been found only in certain sites. *Post hoc* differences in means were determined using Fisher's least significant difference (LSD) test ($a = 0.05$) (SAS Institute 2002).

RESULTS

Interspecific Associations. One hundred ninety vascular taxa occurred within the 362 sampled quadrats across all eight sites (Appendix). Twenty species had $> 5\%$ quadrat occurrence across all study sites. *Andropogon gerardii* stem counts were greater in quadrats with the following associates and sites: *Lespedeza cuneata* (Dum. Cours.) G. Don (sericea lespedeza) (SP $t = -2.4$, $p < 0.02$; TP $t = -4.06$, $p = 0.001$; SNFI $t = -3.67$, $p = 0.005$); *Rubus argutus* Link (blackberry) (TP $t = -2.72$, $p = 0.008$; SNFI $t = -\text{Infty.}$, $p < 0.001$; SNFII $t = -4.83$, $p < 0.001$); *Vitis rotundifolia* Michx. var. *rotundifolia* (muscadine grape) (TP $t = -3.23$, $p = 0.002$; OS $t = -3.03$, $p = 0.004$); *Fraxinus sp.* (ash) (TP $t = -6.87$, $p < 0.001$; BJ $t = -3.0$, $p = 0.004$); and *Dichanthelium dichotomum* (L.) Gould var. *dichotomum* (cypress panicgrass) (TP $t = -2.13$, $p = 0.04$).

The −infinity t-value for the association of *R. argutus* with *A. gerardii* at the SNFI site was due to the fact that all values for *R. argutus* were 0 when *A. gerardii* was absent at the site, and conversely the values for *Rubus* were very large when *A. gerardii* was present. This indicates a very strong evidence of an association between *A. gerardii* and *R. argutus*, but the lack of variation causes the t-statistic to generate a −infinity value. In order to recheck the results we conducted a second analysis for this associate with *A. gerardii* for the site using an alternative Fisher's Exact Test that generated a $t = 3.46$ and a $p < 0.001$ that was consistent with the results of the initial t-test. However, in order to be consistent with the t-tests for the occurrence of other associates with *A. gerardii*, we retained the -infinity.

Andropogon gerardii stem counts were lower in quadrats with the following associates and sites; *Dichanthelium scoparium* (Lam.) Gould (velvet witch grass) (SP $t = 4.53$, $p < 0.001$; TP $t = 2.9$, $p < 0.001$); *Rhus copallinum* L. var. *copallinum* (BJ $t = 2.63$, $p = 0.01$); and *Dichanthelium sphaerocarpon* (Elliott) Gould (SP $t = 10.6$, $p < 0.001$).

Plant Cover. Quadrats with *A. gerardii* had significantly higher ($p < 0.01$) total plant cover (73.2%, s.d. 22.6%), as opposed to total cover in quadrats where *A. gerardii* was absent (68.5%, s.d. 24.4%). The mean percent cover for *A. gerardii* was 43.6%, s.d. 27.9%.

Soil Analysis. For all sites pooled together, pH was significantly higher (5.8) in quadrats where *A. gerardii* was present compared to quadrats without *A. gerardii* (5.6) (Table 2). Levels of magnesium, boron, and manganese were also significantly higher in quadrats with *A. gerardii.* However, levels of copper were significantly higher in quadrats without *A. gerardii* (Table 2).

For individual sites, the following soil features had significantly higher values for quadrats with *A. gerardii* for the following sites: magnesium for (SNFI) $F = 25.45$, $p = 0.007$; (BC) $F = 40.15$, $p < 0.003$; copper for (BJ) $F = 17.52$, $p = 0.013$; manganese for (BC) $F = 67.59$, $p = 0.001$; (OS) $F = 3.60$, $p = 0.04$; % carbon for (BC) $F = 24.52$, $p = 0.008$; (SNFI) $F = 14.33$, $p = 0.019$; (SNFII) $F = 11.98$, $p = 0.026$; and CEC for (BC) $F = 40.54$, $p < 0.003$; (SNFI) $F = 111.34$, $p = 0.001$; (SNFII) $F = 21.24$, $p = 0.01$.

However, these soil features had significantly higher values for quadrats without *A. gerardii* for the following sites: calcium for (BC) $F = 106.94$, $p = 0.001$; (BJ) $F = 18.59$, $p = 0.013$; (TP) $F = 10.78$, $p = 0.03$; phosphorus for (BC) $F = 380.39$, $p = 0.001$; zinc for (BC) $F = 30.54$, $p = 0.005$; potassium for (BC) $F = 11.04$, $p = 0.029$; copper for (BC) $F = 288.80$, $p = 0.001$; (SP) $F = 21.0$, $p = 0.01$; and pH for (OS) $F = 10.3$, $p < 0.032$, $F = 10.3$; (BC) $F = 63.16$, $p < 0.001$; (BJ) $F = 9.53$, $p = 0.037$.

DISCUSSION

Interspecific Associations. The composition of associated species in the sampled quadrats was highly variable among the population sites reflecting the high species richness for these

Table 2. Soil parameter means ± standard deviations for quadrats from all three depths combined for all sites with and without the presence of *A. gerardii*. Mean values with different superscripts denote significant differences ($p < 0.05$).

Soil Parameter	With *A. gerardii*	Without *A. gerardii*
pH	$5.8^{A} \pm 0.7$	$5.6^{B} \pm 0.5$
Organic Carbon (%)	$1.8^{A} \pm 1.05$	$1.5^{A} \pm 0.7$
Organic Nitrogen (%)	$0.1^{A} \pm 0.07$	$0.1^{A} \pm 0.08$
Phosphorus (kg/ha)	$7.7^{A} \pm 6.8$	$26.0^{A} \pm 44.0$
Potassium (kg/ha)	$70.0^{A} \pm 54.9$	$53.8^{A} \pm 27.3$
Calcium (kg/ha)	$1130.3^{A} \pm 874.5$	$1195.5^{A} \pm 1119.3$
Magnesium (kg/ha)	$552.4^{A} \pm 673.5$	$412.3^{B} \pm 402.9$
Copper (kg/ha)	$3.3^{A} \pm 2.6$	$6.1^{B} \pm 7.4$
Boron (kg/ha)	$0.7^{A} \pm 0.6$	$0.4^{B} \pm 0.4$
Zinc (kg/ha)	$3.4^{A} \pm 2.6$	$4.1^{A} \pm 4.3$
Manganese (kg/ha)	$40.0^{A} \pm 28.4$	$32.6^{B} \pm 24.3$
CEC (meq/100g)	$7.6^{A} \pm 3.1$	$7.4^{A} \pm 4.1$

sites. However, patterns of associations between *A. gerardii* and several associated species for some study sites were detected. For those associates that occurred in the quadrats where *A. gerardii* stem counts were greater, *Lespedeza cuneata* and *Rubus argutus* were significant for more sites, and for several of the largest and highest quality *A. gerardii* populations. Likewise, for those associates that occurred in the quadrats where *A. gerardii* stem counts were lower, *Dichanthelium scoparium* was significant for the larger *A. gerardii* populations at both Suther and Troy Prairies. Although it is not possible to make conclusive statements about the causal factors that may be forming these associations, they may have potential implications for the long-term maintenance of these *A. gerardii* populations.

Lespedeza cuneata occurred in quadrats with *A. gerardii* for six of the sites. Although significant for only three, they included both Suther and Troy Prairies (Figure 2). Because *L. cuneata* is a relatively recent introduction, its long-term impact on endemic species is not well understood. It has also been reported to occur in plots with other grass species having dense fibrous root systems (e.g., *Festuca arundinacea* Schreb. and *Bromus secalinus* L.) (Brandon et al. 2004). One field study where *A. gerardii* occurred with 5 tap-rooted forbs found no effect on above- and belowground production on *A. gerardii*, whereas *A. gerardii* biomass was significantly reduced both above- and belowground where it occurred with 5 rhizomatous species (Dwyer 1958; see Jastrow and Miller 1993). Brandon et al. (2004) further suggested that the taproot system of *L. cuneata* was unlikely to interfere with neighboring fibrous root systems.

It has been suggested that species with differing spatial niches, or root architecture, may reduce root competition among neighboring plants (Rubio et al. 2001) and provide a means

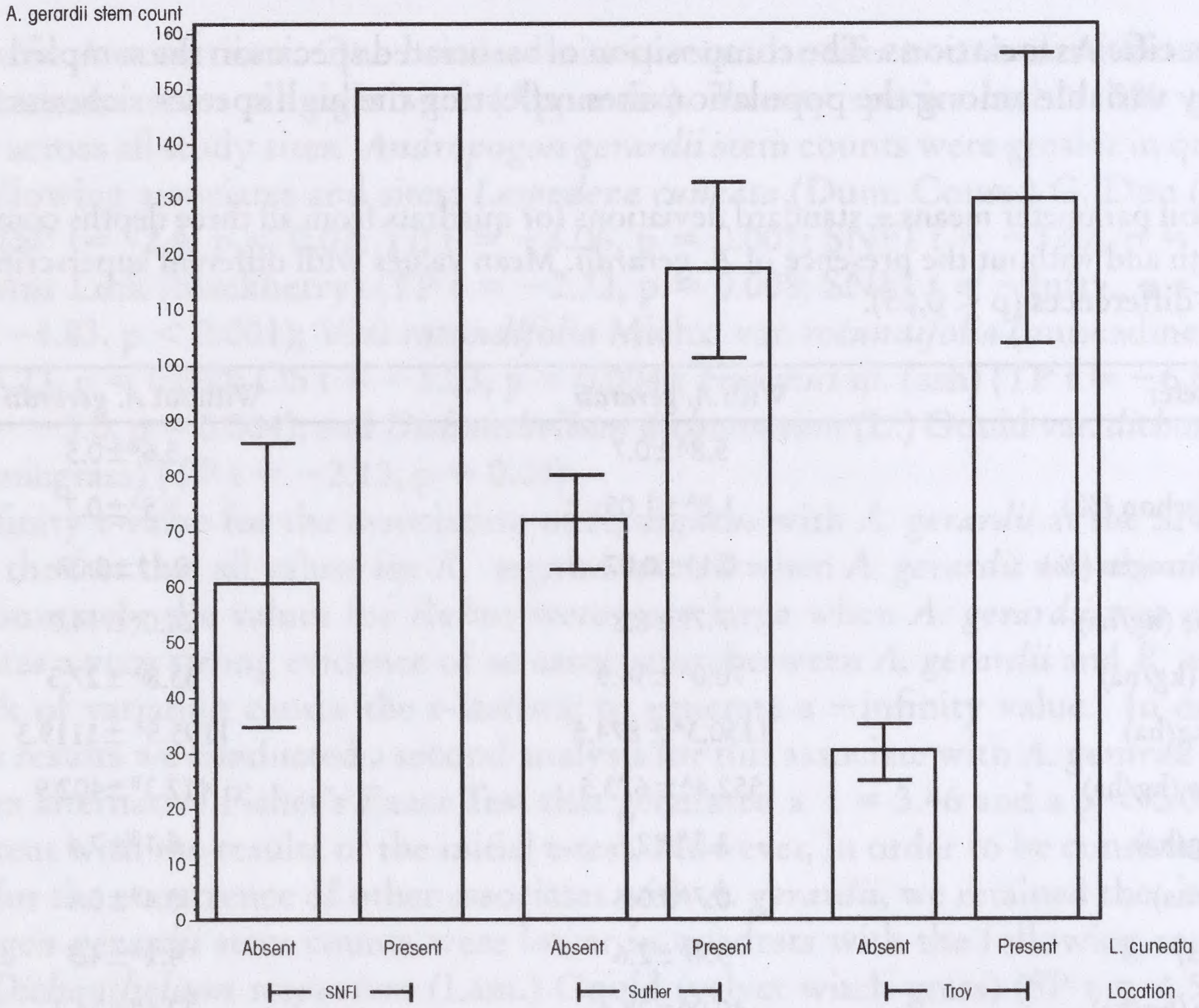

Figure 2. Mean *A. gerardii* stem counts with error bars for quadrats with and without *L. cuneata* for sites SNFI, Suther and Troy Prairies.

for maximizing resource availability between species (Harper 1977; Aarssen and Turkington 1985; Silvertown 1987). *Lespedeza cuneata* has a taproot system (Hoveland and Donnelly 1985; Brandon et al. 2004) while *A. gerardii* has a dense network of underground rhizomes and roots. Weaver (1958; 1963) estimated a mean length of 174 m/m^2 for rhizomes from sections of sod from *A. gerardii* from midwestern studies. As a result, the highly invasive *L. cuneata* may be able to take advantage of available below-ground space because of its taproot structure in sites with *A. gerardii*. Thus, the spatial distribution of below-ground structures for these two species may be an example of resource partitioning due to variation in root/rhizome morphology (Bazzaz 1991).

In addition to the potential shared utilization of below-ground space between these two species, certain benefits to each may result due to their close association. For example, it is possible that *A. gerardii* may benefit from the transfer of nitrogen fixed by *L. cuneata* where they co-occur. The yield of grass species in legume-grass mixtures has been shown to exceed that of grass monocultures (Whitehead 1995). Levels of nitrogen transfer can range between 0 and 75% in these associations (Briske 1995). However, for this study, nitrogen levels in quadrats where *A. gerardii* and *L. cuneata* co-occurred were not significantly different from quadrats where *A. gerardii* was absent (Table 2). In addition, other studies have indicated that *L. cuneata* may provide less nitrogen to the soil than other legumes (Ritchie and Tilman 1995). In one such reclamation study, *L. cuneata* supplied negligible levels of nitrogen for the first 6 years after establishment, although soil nitrogen levels did improve slightly during the 7-9 year interval after establishment (Mays and Bengston 1985). *Andropogon gerardii* has also been reported to benefit from increased colonization by mycorrhizal fungi when it occurs with certain forb and grass neighbors, rather than with conspecifics (Jastrow and Miller 1993). For example, Casper and Castelli (2007) found that *A. gerardii* biomass was lower in treatments with conspecific neighbors, and unaffected by competition with two other grass species.

Although resource partitioning may reduce below-ground competition for resources between *A. gerardii* and *L. cuneata*, and potentially yield other biotic benefits to both, any below-ground competitive trade-offs or benefits between each may be outweighed by the detrimental long-term competition from *L. cuneata* where they occur in close proximity. In a study by Allred et al. (2010) that compared physiological and morphological characteristics between *L. cuneata* and *A. gerardii*, they found that total and specific leaf area production was greater for *L. cuneata* earlier in the growing season and exceeded that of two species, including *A. gerardii*. Their results suggested that this may give individuals of *L. cuneata* a "head-start," leading to a competitive advantage in terms of light utilization where they co-exist. Brandon et al. (2004) also suggested that shading effect from individuals of *L. cuneata* was the primary mechanism for suppressing other co-occurring species. Stritzke (1999) and Stritzke et al. (2001) reported that grasses were able to tolerate *L. cuneata* stem densities of 22-86/m^2 before being negatively affected.

Several midwestern studies have also reported that *L. cuneata* is able to suppress native prairie vegetation richness and growth (Dwyer 1958; Foster and Gross 1997; Eddy and Moore 1998; Eddy 1999; Foster 2000; Brandon et al. 2004; Blocksome 2006), including inhibiting *A. gerardii*, particularly during the recruitment and early establishment periods (Foster and Gross 1997; Foster 2000). Studies have indicated that *A. gerardii* biomass is negatively affected by neighbor species and that when neighbor plants are removed, *A. gerardii* biomass and recruitment increases (Foster and Gross 1997; Foster 2000). These studies have also reported a reduction in *A. gerardii* seedling recruitment in sites with greater neighbor and litter biomass. Foster (2000) suggested that as a result of intense competition, *A. gerardii* may be more restricted to low productivity sites in some grasslands.

As with *L. cuneata*, *A. gerardii* stem counts were higher in three of the five sites with *Rubus argutus*, including Troy Prairie. Although *R. argutus* is considered a native species in these eastern prairie ecosystems, it is highly ruderal and able to invade nearby sites via rhizomes (Innis 2005). Also, like *L. cuneata*, it may pose a competitive threat with an increase in aboveground biomass. Foster (2000) found that *R. argutus* inhibited *A. gerardii* biomass production in unweeded plots. Unless sites receive regular burns and/or mechanical thinning, *R. argutus* may quickly spread via runners and shade out other species.

Dichanthelium scoparium was a common species in quadrats for both Suther (36%) and Troy Prairies (24%). It forms extensive below-ground structures and dense mats in the landscape. As a result, it may be more likely to compete for underground resources with *A. gerardii* and, thus, less likely to co-exist in the same microsites. Like *A. gerardii*, *D. scoparium* is also adapted to hydric conditions as well as very dry sites that are characteristic of the dry soil conditions over much of the Troy Prairie site.

In addition to the potential competition for below-ground space between *A. gerardii* and *D. scoparium*, the dense vegetative cover produced by *D. scoparium* may inhibit *A. gerardii* (Weaver and Rowland 1952; Knapp and Seastedt 1986; Foster and Gross 1997; Tompkins and Stucky 2000; Benson 2001). Results from a study by Tompkins and Stucky (2000) suggested that the dense vegetative cover from concentrated individuals of *D. scoparium* may potentially prevent seed rain and seedling establishment of individuals of the prairie remnant legume *Acmipson helleri* (Britton) A.A. Heller (carolina prairie-trefoil) = [*Lotus unifoliolatus* (Hook.) Benth. var. *helleri* (Britton) Kartesz & Gandhi; *Lotus helleri* Britton] into neighboring sites.

Further experimentation is needed to determine any causal factors for the co-occurrence of *A. gerardii* with either *L. cuneata*, *R. argutus* or *D. scoparium* in these sites and to what extent, if any, there is competitive interaction between these species.

Plant Cover. The higher percentage of vegetative cover in quadrats with *A. gerardii* was primarily the result of the dense clonal growth pattern of *A. gerardii*. The concentric pattern produced by the addition of new ramets during each growing season results in an increase in the overall diameter of each plant clone. As new ramets are added along the periphery of each year's additional growth, the central section of each clone experiences the gradual death of rhizomes, thus leaving a centralized barren area within each vegetative clone. Keeler (2004) estimated the generation time for an eastern Colorado population of *A. gerardii* as 50-100 years. This "phalanx-like" growth form is characterized by the production of ramets with a compact spatial arrangement. In contrast, some plant species use a "guerrilla-like" foraging strategy characterized by widely spaced ramets that can extend further into available nearby habitat for available resources (Doust 1981). Silander (1985) noted that genets of guerrilla species would be more likely to interact with ramets of other clones or species. In contrast, the ramets of phalanx species would be more likely to interact with ramets of the same genet. In addition, some of the unoccupied area around the periphery of each *A. gerardii* clone may be due to the shading out of other neighbor species by the taller *A. gerardii* stems, or by *A. gerardii* out-competing nearby species for available below-ground resources.

Soils. *Andropogon gerardii* appears to be adapted to a wide range of local soil nutrient and moisture conditions in the Carolinas. The apparent adaptation of *A. gerardii* to soil conditions of low nutrient availability suggests that it may compete well in patchy environments with lower levels of certain nutrients. Other studies on neighbor competition with *A. gerardii* have also suggested that its ability to thrive in unproductive environments is due to its ability to compete effectively for soil resources (Foster 2000).

In addition, *A. gerardii* may potentially contribute to soil nutrient enrichment in some sites. Casper et al. (2008) reported that in a greenhouse study, three grass species had higher biomass production when grown in removed prairie soil trained (removed from underneath individuals in native sites) by *A. gerardii*, compared to the other grass species in the study. Although no conclusive causal agents were identified as augmenting soil nutrient levels in the study, soil trained by *A. gerardii* had higher levels of both magnesium and calcium compared to three other grass species, and higher potassium levels compared to all but one of the species. For this study, magnesium levels were also significantly higher in quadrats with *A. gerardii* for two sites (SNFI, BC); however, calcium levels were significantly higher in quadrats where *A. gerardii* was absent for three sites (BJ, BC, TP) and potassium for one site (BC). It is not clear from these initial findings that the occurrence *A. gerardii* contributes to higher nutrient levels in microsites in these sites. However, more extensive sampling of these sites is necessary to better assess the occurrence of plant-soil feedback mechanisms.

Andropogon gerardii is an obligate mycotrophic species (Hartnett et al. 1993) that is known to vary in its dependence on mycorrhizal fungi in midwestern populations (Anderson et al. 1994; Schultz et al. 2001). Schultz et al. (2001) found that *A. gerardii* benefits from mycorrhizal associations in low phosphorus soils, but is not dependent on these associations in soils with higher levels of phosphorus. In this study, phosphorus levels were not significantly different for quadrats with *A. gerardii* compared to quadrats without *A. gerardii* (Table 2). Some studies have indicated that the competitive dominance of *A. gerardii* is dependent on mycorrhizal associations (Hartnett et al. 1993). To date, the mycorrhizal associations in Carolina populations of *A. gerardii* are unknown.

Although pH was higher for quadrats with *A. gerardii* when compared across all of the study sites, pH levels for the sites ranged from 4.8 at Troy Prairie to 6.8 at Buck Creek Serpentine Barren. Furthermore, the pH levels were not significantly different ($F = 4.34$, $p = 0.106$) for quadrats with *A. gerardii* at Troy Prairie (pH = 4.8) compared to those without *A. gerardii* (pH = 5.1). Although the *A. gerardii* population at Troy Prairie is among the three largest for the Carolinas, the soils at the site are more acidic and have relatively lower levels of most nutrients compared to the other *A. gerardii* sites (Tompkins et al. 2010a; 2010c). This would seem to indicate broad adaptation for various soil conditions, including lower soil pH levels. Thus, although the results of this study suggest that *A. gerardii* may have a preference for microsites that have higher pH levels, it appears to be adapted as well to very acidic soil conditions.

The potential competition for space in quadrats between *A. gerardii* and *L. cuneata* at the more nutrient rich Suther Prairie compared to Troy Prairie with lower overall nutrient levels, indicates that overall competitive ability was not related to soil resource levels for those sites (Tilman 1988). These findings seem to be inconsistent with the C-S-R model of Grime (1977) that predicts that intensity of competition decreases from most to least productive habitats. For these remnant prairie communities, soil nutrient levels probably play a less important role in overall competition between associated species compared to access to light and reduced competition from mid-to late successional species.

Management Considerations. Based on the results of this study, certain aggressive native and non-native species may require intensive management for some of the sites. Periodic maintenance (mowing, fire regime, clear-cutting) likely prevents most invasive and ruderal species from reaching a level of biomass production that might inhibit the presence of *A. gerardii* and other prairie endemics. For *R. argutus* and *D. scoparium*, frequent burns and mechanical thinning may be sufficient to maintain biomass at low enough levels to reduce competitive interaction which may inhibit *A. gerardii* and other native species. However, for an introduced species such as the aggressive *L. cuneata*, that is relatively recent to these ecosystems, it may have the potential to drastically reduce native species despite periodic maintenance of the sites. To date, its management and control in midwestern prairie communities has proven to be difficult (Farris and Murray 2009). The lack of a clear solution to control *L. cuneata* is confounded by the fact that the very procedures (periodic burns, and mechanical thinning of mid-late successional species) that are used to maintain optimal prairie conditions may actually benefit the expansion of *L. cuneata* in those same sites.

Fire has been reported to kill *L. cuneata* seedlings, but only "top-kills" established plants. Established plants typically sprout from below-ground structures (Farris 2006), and may scarify dormant seeds of *L. cuneata*, increasing germination rates (Segelquist 1971). If fire is part of the management regime for a site, fall burns may be more effective at removing established plants of *L. cuneata* (Hamilton 2003). Seasonal mowing for hay, which is done at Suther Prairie, may actually encourage the growth of *L. cuneata* seedlings, which need high light levels (McGraw and Hoveland 1995; Brandon et al. 2004). Brandon et al. (2004) found that spring mowing increased stem density and cover of *L. cuneata*, compared to unmowed plots, and found no differences between spring vs. fall mowed plots for levels of *L. cuneata* biomass, cover, and stem density. However, continual clipping of *L. cuneata* throughout the growing season did allow an increase in native species establishment compared to unclipped plots (Brandon et al. 2004). Mowing too frequently, however, will likely interfere with the flowering phenology of other species and potentially threaten those populations.

Studies have shown that herbicide application has had some degree of effectiveness in the control of *L. cuneata*, particularly of pre-emergence herbicides targeting seed germination (Farris and Murray 2009). However, the use of herbicides in these ecosystems may be impractical and threaten native species. These prairie sites are relatively small with many rare to uncommon species, and are very susceptible to species loss or reductions in the size of populations. As a result, it is often difficult to reduce invading species with herbicide application without hurting native species (Rinella et al. 2009).

Although labor intensive, a possible solution for some sites, due to their small relative size, may be the physical spot removal of *L. cuneata* stems by hand in conjunction with current management protocols. However, any management options to control for *L. cuneata* should include techniques that do not negatively affect other native species in those sites.

CONCLUSIONS

Frequency and percent cover data from these populations indicated that *A. gerardii* is a dominant species (Tompkins et al. 2010a). At present, with regular management (fire and clear-cutting to remove mid-late successional species), populations of *A. gerardii* at these sites appear to be stable (Tompkins et al. 2010a). However, the results from this study suggest that the potential competitive impact of associated species, particularly *L. cuneata* and other invasives, on *A. gerardii* and other rare eastern prairie endemics needs more study. In addition, studies have also shown that an increase in plant litter may also inhibit

A. gerardii recruitment. Although, the historic decline of *A. gerardii* and other prairie endemics in the Carolinas is due primarily to land use changes and competition from mid- to late successional species, reduced recruitment (Foster 1999) may also threaten current *A. gerardii* populations. Any additional reduction in recruitment due to increased levels of plant litter from nearby associates, may further suppress already low recruitment levels as a result of low viable seed production due to obligate outcrossing (Tompkins et al. 2011). The findings from an outcrossing reciprocity study with nine *A. gerardii* populations, including eight from this study, suggested that viable seed production is low or absent, particularly in smaller *A. gerardii* populations. As these prairie communities have become more fragmented, the potential for successful outcrossing among individuals of *A. gerardii* has probably been reduced (Tompkins et al. 2011).

The findings of this study should provide a better understanding of both the microhabitat ecology of *A. gerardii* populations in the Carolinas, and the overall ecology of Piedmont prairie communities. In addition, the authors hope that the information will contribute to the management and restoration of eastern *A. gerardii* populations in the future.

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APPENDIX

Species list from sampled quadrats for all 8 sites. Site abbreviations: **SP** = Suther Prairie; **TP** = Troy Prairie; **BJ** = Blackjacks Heritage Preserve; **BB** = Bowman Barrier Rd.; **OS** = Orton Site; **BC** = Buck Creek Serpentine Barren; **SNFI** and **SNFII** = Sumter National Forest Sites I and II. Collector's abbreviation follow by accession number: **RT** = Robert Tompkins. All specimens stored in Clemson University (CLEMS) and Belmont Abbey College Herbaria.

ACANTHACEAE

Ruellia caroliniensis (J.F. Gmel.) Steud. (SP - RT0586, BJ - RT0385)

ALISMATACEAE

Sagittaria latifolia Willd. var. *latifolia* (TP - RT0352)

ALLIACEAE

Allium canadense L. var. *canadense* (SP - RT0073, BC - RT0618)

ALTINGIACEAE

Liquidambar styraciflua L. (SP - RT0794, TP - RT0662)

AMARYLLIDACEAE

Zephyranthes atamasca (L.) Herb. (SP - RT0022)

ANACARDIACEAE

Rhus copallinum L. var. *copallinum* (TP - RT0669, BJ - RT0680, OS - RT0729)
Rhus glabra L. (SNFII - RT0711)
Toxicodendron radicans (L.) Kuntze var. *radicans* (SP - RT0734, TP -RT0667, BJ - RT0688)

APIACEAE

Cicuta maculata L. var. *maculata* (SP - RT0232)
Daucus carota L. (SP - RT0231)
Ptilimnium capillaceum (Michx.) Raf. (SP - RT0012)

APOCYNACEAE

Apocynum cannabinum L. (SP - RT0199)
Asclepias rubra L. (TP - RT0520)

ASTERACEAE

Ageratina altissima King & H. Rob. var. *altissima* (SP - RT0267, TP - RT0755, BB - RT0238)
Ambrosia artemisiifolia L. (SP – RT0699, TP - RT0663, SNFI – RT0292)
Bidens frondosa L. (SP - RT0683, BJ - RT0006)
Cirsium vulgare (Savi) Ten. (SP - RT0258)
Conyza canadensis (L.) Cronquist var. *canadensis* (SP – RT0687, SNFI – RT0294)
Coreopsis lanceolata L. (SP - RT0083)
Coreopsis major Walter var. *rigida* (Nutt.) Boynt. (TP - RT0158, BC - RT0620)
Erigeron strigosus Muhl. ex Willd. var. *strigosus* (SP - RT0097, TP - RT0666)
Eupatorium album L. var. *album* (TP - RT0360)
Eupatorium capillifolium (Lam.) Small (SP - RT0440, TP - RT0665)
Eupatorium hyssopifolium L. (TP - RT0682, BJ – RT0670)
Helianthus atrorubens L. (TP - RT0332, BC - RT0407)
Helianthus divaricatus L. (TP - RT0325, BC - RT0619)
Lactuca canadensis L. (SNFI - RT0251)

Leucanthemum vulgare Lam. (SP - RT0090, SNFI - RT0709)
Marshallia obovata (Walter) Beadle & Boynt. var. *obovata* (SP - RT0092, TP -RT0468, BJ - RT0681)
Oligoneuron album (Nutt.) G.L. Nesom (BJ - RT0381)
Parthenium integrifolium L. var. *integrifolium* (TP - RT0156, SNFII - RT0710)
Pityopsis aspera (Shuttlw. ex Small) Small var. *adenolepis* (Fernald) Semple & F.D. Bowers (SP - RT0761, TP - RT0311, SNFII - RT0254)
Rudbeckia hirta L. var. *hirta* (BC - RT0543)
Sericocarpus asteroides (L.) Britton, Sterns, & Poggenb. (SNFII - RT0249)
Sericocarpus linifolius (L.) Britton, Sterns & Poggenb. (TP - RT0330, BJ - RT0186)
Silphium compositum Michx. var. *compositum* (TP - RT0629, BC - RT0621, SNFII - RT0253)
Silphium terebinthinaceum Jacq. (BJ - RT0378)
Solidago gigantea Aiton (SP - RT0306, TP - RT0649)
Solidago gracillima Torr. & A. Gray (TP - RT0322)
Solidago nemoralis Aiton var. *nemoralis* (SP - RT0432, TP - RT0344, BJ -RT0382, BC - RT0416)
Solidago patula Muhl. ex Willd. var. *patula* (TP - RT0768)
Solidago pinetorum Small (TP - RT0336)
Solidago radula Nutt. (TP - RT0352)
Symphyotrichum dumosum L. (SP - RT0443, TP - RT0341, BJ - RT0762, BC - RT0420, OS - RT0730)
Symphyotrichum grandiflorum (L.) G.L. Nesom (TP - RT0363)
Symphyotrichum rhiannon Weakley & Govus (BC - RT0403)

BETULACEAE

Alnus serrulata (Aiton) Willdenow (TP - RT0326)

BIGNONIACEAE

Campsis radicans (L.) Seem. ex Bureau (SP - RT0740, TP - RT0635, BJ - RT0774)

CAMPANULACEAE

Campanula divaricata Michx. (BC - RT0389)
Triodanis perfoliata (L.) Nieuwl. (SP - RT0089, TP - RT0462, SNFI - RT0700)

CAPRIFOLIACEAE

Lonicera japonica Thunb. (SP - RT0752, BJ - RT0678)

CARYOPHYLLACEAE

Dianthus armeria L. var. *armeria* (SP - RT0229)

COMMELINACEAE

Tradescantia ohiensis Raf. (SP - RT0023)

CYPERACEAE

Carex atlantica L.H. Bailey (SP - RT0044, TP - RT0460)
Carex bushii Mack. (SP - RT0066)
Carex caroliniana Schwein. (BJ -RT0193, BB - RT0513)
Carex flaccosperma Dewey (SP - RT0085, TP - RT0651, BJ - RT0686)
Carex scoparia Schkuhr ex Willd. var. *scoparia* (SP - RT0756, TP - RT0493, BC - RT0548, BB - RT0498)
Carex stricta Lam. (SP - RT0047)
Carex tenera Dewey var. *tenera* (SP - RT0086)
Carex vulpinoidea Michx. (SP - RT0067)
Cyperus echinatus (L.) Wood (SP - RT0221)
Cyperus erythrorhizos Muhl. (SP - RT0280, TP - RT0592)
Cyperus pseudovegetus Steud. (SP - RT0279)

Cyperus strigosus L. (SP - RT0011)
Eleocharis tricostata Torr. (SP - RT0076)
Eleocharis tuberculosa (Michx.) Roem. & Schult. (TP - RT0347)
Fimbristylis autumnalis (L.) Roem. & J.A. Schult. (TP - RT0353)
Fuirena squarrosa Michx. (TP - RT0320)
Rhynchospora caduca Elliott (SP - RT0009, TP - RT0648)
Rhynchospora glomerata (L.) Vahl. var. *glomerata* (SP - RT0010, TP - RT0323)
Rhynchospora gracilenta A. Gray (TP - RT0350)
Rhynchospora recognita (Gale) Kral (TP - RT0317)
Scirpus atrovirens Willd. (SP - RT0068, TP - RT0634)
Scirpus pendulus Muhl. (SP - RT0307a)
Scleria muehlenbergii Steud. (TP - RT0307b)
Scleria triglomerata Michx. (TP - RT0149)

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) A. Heller (TP - RT0167, BC - RT0621, OS - RT0731, SNFI - RT0712)

EBENACEAE

Diospyros virginiana L. (SP - RT0739, TP - RT0630, BJ - RT0679, OS - RT0769)

ERICACEAE

Lyonia ligustrina (L.) DC. var. *foliosiflora* (Michx.) Fernald (TP - RT0153)
Vaccinium stamineum L. var. *stamineum* (BC - RT0422, SNFII - RT0473)
Vaccinium tenellum Aiton (TP - RT0349)

EUPHORBIACEAE

Euphorbia corollata L. (SNFII - RT0244)
Tragia urticifolia Michx. (SP - RT0738, BJ - RT0696)

FABACEAE

Apios americana Medik. (SP - RT0005)
Baptisia tinctoria (L.) R. Br. (TP - RT0177)
Chamaecrista fasciculata (Michx.) Greene var. *fasciculata* (SP - RT0263, BJ - RT0676)
Desmodium canescens (L.) DC. (SP - RT0003, BC - RT0629)
Desmodium ciliare (Muhl. ex Willd.) DC. (SP - RT0296)
Desmodium paniculatum (L.) DC. var. *paniculatum* (SP - RT0445, TP - RT0588)
Lespedeza cuneata (Dum. Cours.) G. Don (SP - RT0262, TP - RT0652, BJ - RT0685, BC - RT0622, SNFI - RT0702)
Lespedeza procumbens Michx. (SP - RT0298, TP - RT0633, BB - RT0508, SNFII - RT0713)
Lespedeza virginica (L.) Britton (TP - RT0653)
Mimosa microphylla Dryand. (TP - RT0646)
Orbexilum pedunculatum (Mill.) Rydb. var. *psoralioides* (Walter) Isely (BJ - RT0182)
Stylosanthes biflora (L.) Britton, Sterns & Poggenb. (TP - RT0310)
Tephrosia virginiana (L.) Pers. (TP - RT0701, SNFI – RT0467)
Trifolium campestre Schreb. (SP - RT0737)

FAGACEAE

Quercus marilandica Münchh. var. *marilandica* (TP - RT0631, SNFII - RT0714)
Quercus stellata Wangenh. (TP - RT0753, BJ - RT0647)

GENTIANACEAE

Sabatia angularis (L.) Pursh (SP - RT0265)

HYPERICACEAE

Hypericum denticulatum Walter (BJ - RT0386)
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray (TP - RT0315)
Hypericum gentianoides (L.) Britton, Sterns & Poggenb. (TP - RT0309)
Hypericum mutilum L. var. *mutilum* (SP - RT0285)
Hypericum prolificum L. (SP - RT0260, BB - RT0726, SNFI - RT0256)

IRIDACEAE

Sisyrinchium mucronatum Michx. (SP - RT0024)

JUNCACEAE

Juncus acuminatus Michx. (SP - RT0063, TP - RT0757)
Juncus effusus L. var. *solutus* Fernald & Wiegand (SP - RT0224, TP - RT0758)
Juncus scirpoides Lam. var. *scirpoides* (SP - RT0069, TP - RT0150)
Juncus tenuis Willd. (SP - RT0735, TP - RT0632)

LAMIACEAE

Prunella vulgaris L. (SP - RT0233, BJ - RT0684, OS - RT0773)
Pycnanthemum tenuifolium Schrad. (SP - RT0198, TP - RT0316, BJ - RT0677, BC - RT0628, BB - RT0725)
Salvia lyrata L. (SP - RT0743, TP - RT0661, SNFI - RT0708)
Scutellaria integrifolia L. (SP - RT0091)

MELASTOMATACEAE

Rhexia virginica L. (TP - RT0178)

NARTHECIACEAE

Aletris farinosa L. (TP - RT0464, BC - RT0561)

OLEACEAE

Fraxinus sp. L. (SP - RT0751,TP - RT0660, BJ - RT0674)

ONAGRACEAE

Ludwigia alternifolia L. (SP - RT0002)
Oenothera biennis L. (SP - RT0088, TP - RT0642, BJ - RT0191)

OSMUNDACEAE

Osmunda cinnamomea L. var. *cinnamomea* (TP - RT0638)

PINACEAE

Pinus rigida Mill. (BC - RT0613)

PLANTAGINACEAE

Penstemon laevigatus Aiton (SP - RT0054)
Plantago virginica L. (SP - RT0093)

POACEAE

Agrostis hyemalis (Walter) Britton, Stern & Poggenb. (SP - RT0058)
Aira caryophyllea L. (SP - RT0101, TP - RT0466)

Andropogon gerardii Vitman (SP - RT0750, TP - RT0671, BJ - RT0694, BC - RT0764, OS - RT0725, BB - RT0727, SNFI - RT0706, SNFII - RT0718)
Andropogon virginicus L. var. *virginicus* (SP - RT0434)
Aristida dichotoma Michx. (TP - RT0372)
Aristida oligantha Michx. (TP - RT0342)
Arundinaria gigantea (Walt.) Muhl. (TP - RT0371, SNFI - RT0245)
Bromus commutatus Schrad. (SP - RT0099)
Bromus japonicus Thunberg ex Murray (SP - RT0059, BB - RT0511)
Bromus secalinus L. (SP - RT0100)
Chasmanthium laxum (L.) Yates (TP - RT0319)
Danthonia sericea Nutt. (TP - RT0654, SNFI - RT0476)
Danthonia spicata (L.) P. Beauv. ex Roem. & Schult. (SP - RT0606, TP - RT0471, BJ - RT0689)
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckman (SP - RT0080, TP - RT0168, SNFI - RT0248)
Dichanthelium clandestinum (L.) Gould (SP - RT0203, TP - RT0643, BJ - RT0614, BC - RT0625)
Dichanthelium dichotomum (L.) Gould var. *dichotomum* (SP - RT0303, TP - RT0157, SNFII - RT0482)
Dichanthelium scoparium (Lam.) Gould (SP - RT0007, TP - RT0394)
Dichanthelium sphaerocarpon (Elliott) Gould (SP - RT0216, TP - RT0469, BC - RT0409, BB - RT0901, SNFI - RT0241)
Elymus virginicus L. var. *virginicus* (SP - RT0215, TP - RT0658, BJ - RT0690, BB - RT0504)
Eragrostis spectabilis (Pursh) Steud. (SP - RT0436, TP - RT0308, BJ - RT0675)
Festuca elatior L. (TP - RT0644, BJ - RT0195, BC - RT0770)
Festuca paradoxa Desv. (SP - RT0214)
Glyceria striata (Lam.) Hitchc. var. *striata* (SP - RT0077)
Holcus lanatus L. (SP – RT0636a, TP - RT0636b)
Lolium perenne L. var. *aristatum* Willd. (SP - RT0061, OS - RT0732)
Panicum anceps Michx. var. *anceps* (TP - RT0313, BB - RT0721)
Panicum dichotomiflorum Michx. var. *dichotomiflorum* (SP - RT0008)
Panicum rigidulum Bosc ex Nees var. *rigidulum* (SP - RT0426)
Panicum virgatum L. var. *cubense* Griseb. (TP - RT0515)
Panicum virgatum L. var. *virgatum* (BC - RT0546, TP - RT0565, SNFI - RT0247)
Paspalum dilatatum Poir. (SP - RT0266)
Pennisetum glaucum (L.) R. Br. (SP - RT0013, TP - RT0637, BB - RT0722)
Saccharum giganteum (Walter) Pers. (SP - RT0435, TP - RT0331)
Sorghastrum nutans (L.) Nash (SP - RT0305, TP - RT0645, BB - RT0728)
Sphenopholis obtusata (Michx.) Scribn. (SP - RT0060, SNFI - RT0707)
Tridens flavus (L.) Hitchc. (TP - RT0590, BB - RT0240)
Tridens strictus (Nutt.) Nash (BJ - RT0388)
Tripsacum dactyloides (L.) L. var. *dactyloides* (SP - RT0204, TP - RT0657, BB - RT0724)
Vulpia myuros (L.) C.C. Gmel. (SP - RT0056, TP - RT0525)

POLYGONACEAE

Persicaria maculosa Gray (SP - RT0289)

RANUNCULACEAE

Clematis virginiana L. (SNFI - RT0252)
Thalictrum macrostylum Small & A. Heller (BC - RT0398)

RHAMNACEAE

Ceanothus americanus L. var. *americanus* (TP - RT0145, BC - RT0412, SNFII - RT0716)

ROSACEAE

Crataegus uniflora Münchh. (TP - RT0348, BJ - RT0672)
Fragaria virginiana Duchesne (SP - RT0766)
Physocarpus opulifolius (L.) Maxim. var. *opulifolius* (BC - RT0538)
Potentilla simplex Michx. (SP - RT0237a, BB - RT0237b)
Prunus serotina Ehrh. var. *serotina* (TP - RT0640)
Rosa carolina L. (BJ - RT0185)
Rosa multiflora Thunb. ex Murray (SP - RT0693, BJ - RT0746)
Rubus argutus Link (SP- RT0259, TP - RT0760, BJ - RT0692, SNFI - RT0704, SNFII - RT0717)
Sanguisorba canadensis L. (BC - RT0405)

RUBIACEAE

Cephalanthus occidentalis L. (SP - RT0230, BB - RT0719)
Diodia teres Walter (TP - RT0339)
Diodia virginiana L. (SP - RT0720a, TP - RT0641, BB - RT0720b)
Galium circaezans Michx. var. *circaezans* (SP - RT0290)
Galium obtusum Bigelow var. *filifolium* (Wiegand) Fernald (SP - RT0048, BJ - RT0695)

SAPINDACEAE

Acer rubrum L. var. *rubrum* (TP - RT0801, OS - RT0803)

SMILACACEAE

Smilax glauca Walter (BC - RT0540)
Smilax rotundifolia L. (SP - RT0747, BC - RT0627)

SOLANACEAE

Solanum carolinense L. var. *carolinense* (SP - RT0748, BJ - RT0673, SNFI - RT0705)

ULMACEAE

Ulmus alata Michx. (SP - RT0749, BJ - RT0691)

VALERIANACEAE

Valerianella radiata (L.) Dufr. (SP - RT0207)

VITACEAE

Parthenocissus quinquefolia (L.) Planch. (TP - RT0802, OS -RT0804)
Vitis aestivalis Michx. var. *aestivalis* (TP - RT0496)
Vitis rotundifolia Michx. var. *rotundifolia* (TP - RT0639, OS - RT0724)

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Mycorrhizal Status of Knieskern's Beaked Sedge (*Rhynchospora knieskernii*) in the New Jersey Pine Barrens

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ABSTRACT. This paper reports the first record of the mycorrhizal status of the state-endangered plant *Rhynchospora knieskernii* (Knieskern's beaked sedge, formerly Knieskern's beaked rush). Root samples of this plant were obtained from two locations in the New Jersey Pine Barrens. Roots from one site had no mycorrhizal colonization, whereas roots from the second site were weakly colonized by hyphae and arbuscules, sparse vesicles and some spores. It is suggested that this species is facultatively mycorrhizal.

INTRODUCTON

Rhynchospora knieskernii Carey (Knieskern's beaked sedge, formerly Knieskern's beaked rush, family Cyperaceae), is listed as federal-threatened, state-endangered (New Jersey Natural Heritage Program 2010), and is presently restricted to the Pine Barrens of New Jersey, where it occurs in Atlantic, Burlington, Camden, Monmouth, and Ocean counties (Schuyler 1990). This globally rare, early successional, perennial sedge is frequently found in disturbed, sparsely vegetated sites on a substrate of moist to wet gravelly/sandy loam or clay. It also occurs on bog iron deposits and sandy peat in savannahs, depressions, and swales of pitch pine lowlands, in intermittent stream corridors, and natural, shallow, intermittent ponds. Suitable habitats created by human disturbances include power line clearings, road shoulders and edges of potholes, clearings associated with "paper" roads, abandoned clay excavations, and old borrow pits. Intolerant of competition, especially from invading shrubs and trees, *Rhynchospora knieskernii* is often found with other early successional species such as *Muhlenbergia uniflora* (Muhl.) Fernald, *Panicum verrucosum* Muhl., *Aristida longespica* Poir., *Drosera filiformis* Raf., *Drosera intermedia* Hayne, and *Hypericum gentianoides* (L.) Britton, Sterns & Poggenb. Many of its habitats are associated with fluctuating water regimes (Gordon 1993; 1996; Schuyler 1990; U.S. Fish & Wildlife Service 1993). The mycorrhizal status of this species has not been previously reported.

Other species of *Rhynchospora* have been reported as having arbuscular mycorrhizal (AM) associations with varying degrees of root colonization, or as non-mycorrhizal. For example, da Silva et al. (2001) reported the presence of mycorrhizae in three of four *Rhynchospora* species in a humid tropical forest region of Brasil. *Rhynchospora ciliata*

Kükenth. was non-mycorrhizal, *R. corymbosa* (L.) Britton was sparsely mycorrhizal with an average of 15% root colonization, *R. pubera* (Vahl) Boeck. was strongly mycorrhizal with an average of 42% root colonization, and *R. cephalotes* (L.) Vahl was mycorrhizal with 29% colonization at one site and non-mycorrhizal at another site.

Lovera and Cuenca (1996) reported *Rhynchospora barbata* as mycorrhizal with about 8% root colonization in natural wet savannas in the Canaima National Park in southwest Venezuela, and four of five samples were reported as colonized by AM fungi in the same region (Cuenca et al. 1998). These records were discussed in a review of sedge mycorrhizae (Muthukumar et al. 2004) and a review of the phylogenetic distribution of mycorrhizae (Wang and Qiu 2006).

METHODS

Plant samples came from two small occurrences in Ocean County separated by a distance of approximately 12-13 km. Both sites had a history of mechanical disturbance dating from the past ten to fifteen years. Five tufts of *Rhynchospora knieskernii*, each containing four or five fruiting culms, were collected haphazardly on July 19, 2011 from an abandoned, deed-restricted road segment of Swordfish Rd. named Peter Knieskern Reserve, a parcel of land under a Stafford Township easement surrounded by homes in the community of Ocean Acres. Suitable habitat was confined to a sparsely vegetated area 26 m x 7 m (182 m^2) underlain by Downer loamy sand (U.S. Department of Agriculture 1980). Population size has fluctuated considerably at this site, ranging from 178 tufts in 2007 to 700 tufts in 2011. Among the associated species were *Aristida longespica*, *Panicum verrucosum*, *Panicum virgatum* L., *Diodia teres* Walter, *Hypericum gentianoides*, and a few seedlings of *Pinus virginiana* Mill. and *Pinus rigida* Mill.

Eight tufts of *Rhynchospora knieskernii*, each containing one or two flowering/fruiting culms, were collected via a federal permit on August 7, 2011 from a pitch pine lowland within the Air National Guard Gunnery Range in the East Pine Plains south of Warren Grove. The site of approximately 1300 m^2, underlain by both the Lakehurst and Woodmansie soil series (Tedrow 1986), was heavily disturbed about ten years ago during road-building activities. Four sedge specimens were collected from each of the two soil types.

Several scattered patches of *Rhynchospora knieskernii* occupied the moist road edge and intermittently moist-to-wet ditches and small depressions. Population patches ranging from 32.5 m^2 to 102 m^2 produced an estimate of 4000 tufts in 2010 and 3400 tufts in 2011. Co-occuring species were *Panicum virgatum*, *Dichanthelium sp*., *Aristida longespica*, *Drosera intermedia*, *Sphagnum sp*., and *Xyris torta* Sm.

The entire root system of the extracted plants was cleared in 10% KOH and stained in 0.1% Trypan Blue according to the method of Phillips and Hayman (1970), but with each step being conducted over one week at room temperature. Twenty, approximately 1 cm long, root pieces were placed on microscope slides and were observed using a 20 or 40X objective on a Leica DM 100 microscope and digitally imaged using a Moticam 2300 3.0 Mega pixel digital camera. The resultant color images were imported into Adobe Photoshop CS4, where they were converted to monochrome and cropped as necessary, but were otherwise unaltered.

RESULTS AND DISCUSSION

No mycorrhizal structures were seen in samples from the Peter Knieskern Reserve. In the Warren Grove samples, mycorrhizal colonization was estimated to occupy 10-20% of the root system. Colonization was abundant (arbuscules, hyphal coils and spores; Figs. 1 a-f) in some root segments but completely absent from other parts of the same root system. There were no apparent differences in root colonization between the two soil types. We have identified surface hyphae, including dark-septate hyphae, arbuscules (Fig. 1a, b), hyphal coils (Fig. 1c), densely packed cortical cells (Fig. 1d), vesicles (Fig. 1e) and spores (Fig. 1f). Given that mycorrhizal structures were only observed in plants collected from one

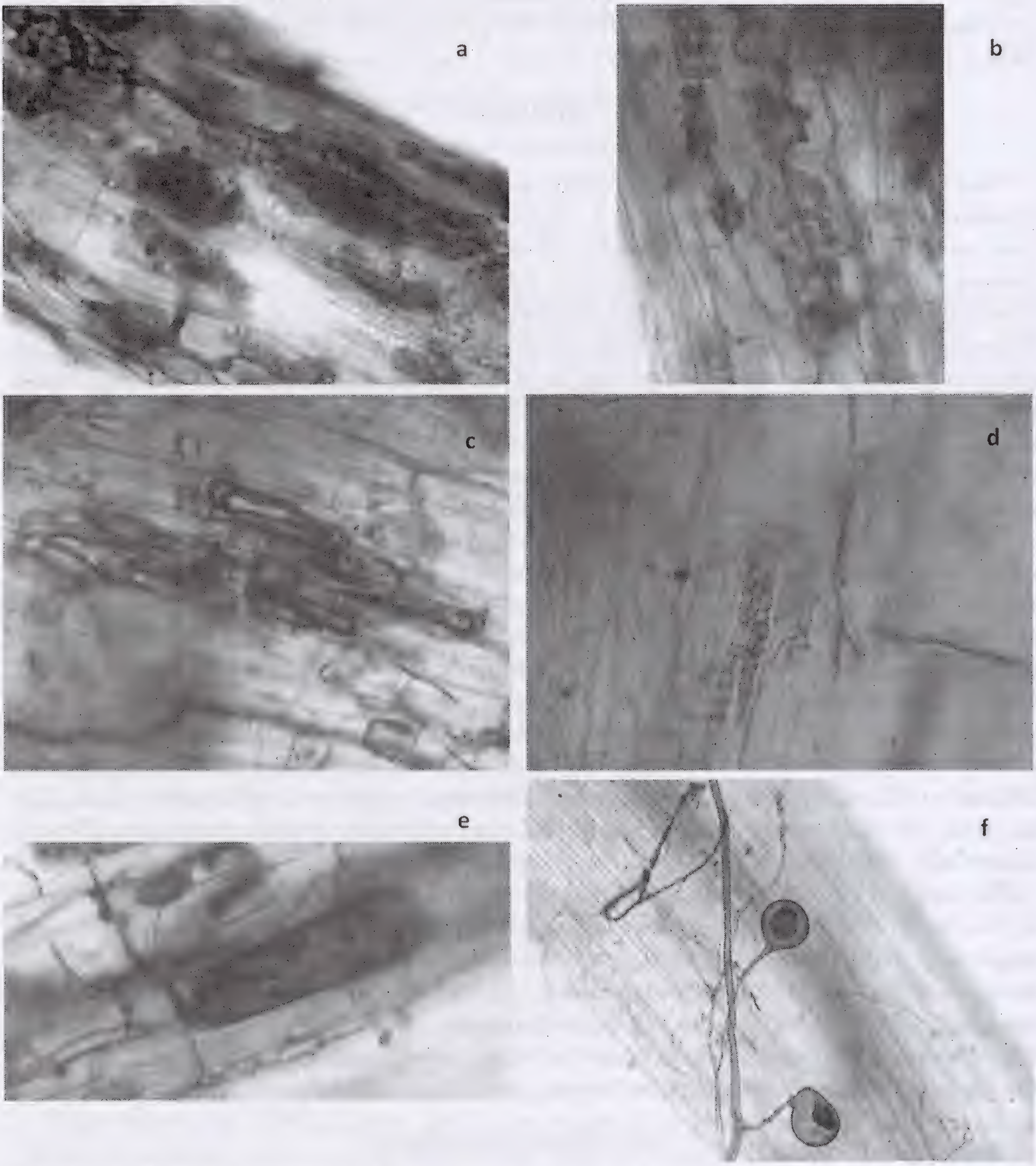

Figure 1. Observed mycorrhizal structures of *Rhynchospora knieskernii*: a. arbuscules (200x); b. arbuscules (400x); c. hyphal coils (400x); d. cortical cell with densely packed hyphal structures (200x); e. vesicle (400x); f. spores (200x).

of the two sites surveyed, we suggest that this species is facultatively mycorrhizal. Further research is needed to determine if edaphic factors or association with other plant species in the community influence the degree of mycorrhizal colonization of the roots.

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The Status and Distribution of *Amaranthus pumilus* Raf. (Seabeach Amaranth) and Other Rare Beach Plant Species in New Jersey: Field Surveys and Historical Records

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ABSTRACT. Systematic field surveys were conducted in ten years from 2001 to 2011 for six rare beach plant species in New Jersey, including the federally-listed (Threatened) plant species, *Amaranthus pumilus* (seabeach amaranth), and five other rare beach plant species (*Polygonum glaucum, Honckenya peploides* var. *robusta, Sesuvium maritimum, Oenothera humifusa, Glaux maritima*). Surveys covered all 130 miles of sandy ocean beaches in New Jersey, and an additional 15 miles of habitat on the Raritan and Delaware Bays. A total of 77 locations were observed for five of the six species (no *G. maritima* were found) in four out of five coastal counties, compared to 89 historical locations in five counties from 200 years of historical records. Field surveys found populations in 44 (49%) of 89 historical locations; nine of these were last observed in the 1800s, 13 in 1900-1979, and 22 in 1980-2000. The 33 *de novo* discoveries effectively increased the total known locations of these rare beach plant species in New Jersey by 37%. Repeated surveys were found to be essential to documenting populations in these dynamic beach ecosystems, with 4-7 survey years required to capture 90% of found populations. Only three locations in New Jersey contained the majority of the study species in the majority of years, all of which had 8-10 miles of contiguous habitat relatively protected from coastal development, hard shoreline stabilization, and incompatible land uses (mechanical beach raking and/or off-road vehicles). A discussion is provided on the distribution and abundance of populations and threats to each of these species in New Jersey. Also discussed is the utility and feasibility of comprehensive, systematic surveys of habitat for rare beach plant species to effectively determine their status and distribution and changes over time.

INTRODUCTION

New Jersey has the longest and most intensive history of coastal development of any barrier island system in North America (Nordstrom 1994), and with it has come the loss of many plant populations, species, and habitats from its shores. More than four dozen coastal plant species of its beaches, dunes, salt marshes, and estuaries are currently listed by the New Jersey Natural Heritage Program (NHP) as endangered, historical, extirpated, and/or special concern (Snyder 2010). Current information about the distribution and abundance of many of these rare plant species is lacking, however, and systematic surveys are needed in order to better determine their conservation status, threats, and factors limiting their recovery.

This paper relates the findings of comprehensive status surveys for six rare beach plant species in New Jersey: the federally listed (Threatened) plant species, *Amaranthus pumilus* (seabeach amaranth), *Polygonum glaucum* (seabeach knotweed), *Honckenya peploides* var.

robusta (seabeach sandwort), *Sesuvium maritimum* (sea purslane), *Oenothera humifusa* (seabeach evening primrose), and *Glaux maritima* (sea milkwort). Surveys were conducted by the author for the New Jersey Department of Environmental Protection, Office of Natural Lands Management (ONLM), and the U.S. Fish and Wildlife Service (USFWS) in ten nearly consecutive years, from 2001-2005 and 2007-2011. The results of these intensive field surveys are herein described and compared to 200 years of historical records for these plant species, including written accounts, herbarium specimens, and previous field surveys, in order to determine long-term changes in the statewide distribution of these species' populations over time and our knowledge of them. Also provided is a discussion of the relative effectiveness of different survey methodologies for providing comprehensive and conclusive status information for these species.

Species Descriptions

Amaranthus pumilus Raf. (seabeach amaranth: Amaranthaceae) is an annual plant occupying the sandy ocean beaches of eastern North America in the narrow strip of land occurring between the high tide line and the base of the dunes. Its range formerly extended from Massachusetts to South Carolina, but factors such as coastal development, hard shoreline stabilization, incompatible land use practices, severe storms, and coastal erosion reduced its range to only a few populations in North and South Carolina by 1989 (Weakley et al. 1996). In the following decade, populations were again observed in New York, Delaware, Maryland, and Virginia (Mangels 1991, Lea and King 2002, McAvoy 2002). *Amaranthus pumilus* was listed as historical in New Jersey until 2000, when populations were rediscovered on northern New Jersey beaches (Walsh 2002). Only Connecticut, Rhode Island, and Massachusetts have yet to report observations of the species within its historical range. Despite these positive trends, the species remains imperiled[1] or critically imperiled throughout its present range (NatureServe 2012), and is listed as Threatened by the USFWS (Weakley et al. 1996).

Polygonum glaucum Nutt. (seabeach knotweed: Polygonaceae) occurs from Massachusetts south to Florida. The habitat of this annual plant includes coastal beaches, dunes, margins of salt ponds, and occasionally salt marshes, dredge spoils, and fill piles. *P. glaucum* is globally vulnerable, with populations declining throughout most of its range, and is critically imperiled in North Carolina, Virginia, Delaware, and Rhode Island, historical in Georgia and Connecticut, and vulnerable in New York and Massachusetts (NatureServe 2012). The species is listed as Endangered in New Jersey, with only two extant populations known at the time these surveys were initiated in 2001 (Snyder 2000, Snyder 2010). The species is occasionally referred to in the literature as *P. maritimum* (Stone 1911).

Honckenya peploides (L.) Ehrh. var. *robusta* (Fernald) Hultén (seaside sandwort: Caryophyllaceae) is a perennial plant species that occurs on sandy beaches, flats, and dunes above the high tide line, and along rocky coasts of eastern North America. The genus is monotypic with four known subspecies, of which only *H. peploides* var. *robusta* occurs in New Jersey. The historical range of the subspecies extended from Virginia north to Newfoundland and Labrador, and as far westward as Prince Edward Island and New Brunswick, Canada. The species is currently listed as imperiled in Rhode Island, historical or extirpated in Virginia, Delaware and New Hampshire, and a candidate for listing in Maryland and Connecticut (NatureServe 2012). In New Jersey it was listed as Special Concern, with less than 10 extant populations known (Snyder 2010, Snyder pers. comm.), and was formally proposed for listing as Endangered as of August 2012 (NJOAL 2012). The species was also historically referred to as *Arenaria peploides, Adenarium maritimum* or *Ammodenia peploides.*

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[1] The terms "critically imperiled," "imperiled," "vulnerable," "historic," and "extirpated" here correspond to specific Natural Heritage rankings that describe the status of each species based on established criteria (NatureServe 2012, Snyder 2010). These are G1, G2, G3, GH, and GX for global rankings, and S1, S2, S3, SH, and SX for state or province rankings, respectively. The terms "Endangered," "Threatened," and "Special Concern" describe the listing status as determined by individual states and/or federal government agencies, though not all agencies use each of these terms (New Jersey currently lacks a "Threatened" status, for example).

Sesuvium maritimum (Walter) Britton, Sterns & Poggenb. (sea purslane: Aizoaceae) occurs from New York south to Florida and west to Texas. The annual species occurs on sandy beaches, wet sands, dune swales, brackish marshes, waste grounds, and ballast (USDA, NRCS 2012). It is rare or endangered in North Carolina, Maryland, New York and Kansas (NatureServe 2012), and imperiled in New Jersey, with less than ten occurrences known (Snyder 2010, Snyder pers. comm.). Synonyms for the species include *S. sessile* (Nuttall 1818), *S. pentandrum* (Britton 1881), and *S. portulacastrum* (Knieskern 1856).

Oenothera humifusa Nutt. (seabeach evening primrose: Onagraceae) is a perennial plant of sandy beaches and dunes occurring from New Jersey south to Florida and west to Louisiana. It is considered vulnerable in Delaware and North Carolina (NatureServe 2012) and is listed as Endangered in New Jersey, but was formally proposed for removal from the Endangered list in August 2012 (NJOAL 2012) and its status changed from critically imperiled to imperiled. The species is occasionally referred to as *Raimannia humifusa* (USDA, NRCS 2012).

Glaux maritima L. (sea milkwort: Primulaceae) is a perennial species that occurs from Virginia north to Newfoundland in eastern North America, and throughout the western United States and Canada. Habitat for the species includes sea beaches, salt marshes, and alkaline or saline soil in meadows, sloughs, streambeds, and lakeshores. The species was proposed for removal from the Endangered list in New Jersey in August 2012 (NJOAL 2012), as it is now considered to be extirpated in the state. The species is also historical or extirpated in Maryland and Rhode Island, and endangered or vulnerable in New Hampshire and several western states and Canadian provinces (Snyder 2010, NatureServe 2012).

Historical Accounts

Historical records of these rare beach plant species date at least to 1802 in New Jersey, with the discovery of *Amaranthus pumilus*, by Samuel Constantine Rafinesque on Tucker's Island (Rafinesque 1836). Other noteworthy collections include the type specimen of *Polygonum glaucum* (seabeach knotweed), which was collected by Thomas Nuttall in 1818 on a nearby beach in "Egg Harbour" (PH). More than 200 specimens of these six beach plant species were eventually collected from the New Jersey shoreline in the century and a half that followed (Snyder unpubl. data), and these records provide a valuable reference for assessing the long-term changes in species distribution and abundance over time.

To some extent the decline and disappearance of beach plant species in New Jersey can be inferred from the changing species descriptions in the historical accounts of the state flora. *Amaranthus pumilus*, for example, was described by Britton (1881) as "frequent along sandy shores," but thirty years later by Stone (1911) as "apparently local and not common," and "rare on the sea beaches…of N.J." by Taylor (1915). Similarly, *P. glaucum* was listed by Torrey (1824) as "common on the sea coast" and by Britton (1881) as "frequent in sands of the seashore," but later by Stone (1911) as "apparently not common" and Taylor (1915) as "uncommon on the sea coast."

The account of *Honckenya peploides* (*Arenaria p.*) by Stone (1911) indicated a decline of the species and was also suggestive of human activities as its cause: "apparently much less common than formerly, and extinct in the vicinity of many of the most populous resorts." Previously, it was described as "not rare" (Knieskern 1856) and "frequent in sands of the sea-shore" (Britton 1881). Harshberger (1900) wrote that *H. peploides,* along with *Cakile edentula,* were the "only ones found commonly on Barnegat Beach at Seaside Park."

For some coastal species, their rarity in New Jersey was due not to human activities, but to the natural limits of the species' range. *Oenothera humifusa,* for example, was described as frequent in upper beaches and sand dunes (Harshberger 1900, Stone 1911), but occurred only in Cape May and Atlantic Counties, where it reached its northern range limits. Similarly, the northern *Glaux maritima* was described by Nuttall (1818) as "found on every sea-coast in the northern hemisphere, within the temperate regions," but Torrey (1824) noted he "searched for this plant in vain" in the vicinity of New York City. Britton considered it a "fugitive from the north" (Stone 1911), and it was collected only once in New Jersey at Deal beach in the 1800s.

For other species such as *Sesuvium maritimum,* the written accounts of their status were conflicting: described as "rare" by some (Knieskern 1856, Willis 1874) and "frequent" (Britton 1881) by others, with no apparent temporal trend. Stone (1911) presented an intermediate impression, identifying it as "occasional on sea beaches; not nearly as abundant in New Jersey as most statements would lead one to suppose." In either case, as suggestive as these brief descriptions may or may not be, they are unreliable as a means to decipher the historical status and distribution of the species or any population trends over time. To do so, a more comprehensive assessment of the historical record is needed, including herbarium specimens, published accounts, and prior field surveys for these six species in the state, which is one of the primary goals of this paper.

Status Surveys

In contrast to the early history of specimen collections and other botanical studies, few to no collections or published accounts of these rare beach species were made after the 1930s in New Jersey, and over time the knowledge of the status and whereabouts of many of these species' populations generally declined with the passing of the botanists who had studied them.[2] In order to begin to fill these knowledge gaps and determine to what extent populations of these species still existed in New Jersey, surveys of various localities were conducted by botanist David Snyder in the late 1970s through late 1990s (Snyder 1996, 2000, pers. comm.). These efforts resulted in the discovery of *Polygonum glaucum* in New Jersey, which had not been seen since 1969 (Snyder 1989), as well as several populations of *Honckenya peploides, Sesuvium maritimum,* and *Oenothera humifusa* at historical and/or *de novo* sites (Snyder unpubl. data). In all, more than 30 collections of these four species were made by Snyder between 1980 and 2000 (Snyder unpubl. data), documenting extant populations in 11 of 15 historical locations at the county level for these four species, some of which had not been documented for more than 100 years.

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[2] This included a generation of botanists such as Vincent Abraitys, Lou Hand, Frank Hirst, Gil Cavileer, and others, who were known to have searched for these species in the 1950s through 1970s and had, in some cases, recorded observations of them in their extensive personal card files or field notes. No populations of *A. pumilus,* however, were ever found (Snyder pers. comm.).

Given the global rarity and national conservation significance of the federally listed *A. pumilus*, surveys for this species were among the most intensive. As part of coordinated rangewide status surveys funded by the USFWS, 17 surveys of 15 sites on the state coastline were conducted in 1986-1987 and 1996 to determine whether the species still existed in the state (Snyder 1996). These searches consisted primarily of visits to historical sites where specimens had been collected, and/or where large areas of suitable habitat remained. These surveys built upon a background of more extensive searches for this species in areas such as Holgate and Sandy Hook, the latter of which was surveyed by Snyder in 15 out of 20 years from 1977 to 1996 (Snyder unpubl. data). No populations of *A. pumilus* or *G. maritima*, however, were ever found by Snyder or others in New Jersey, including several authors who conducted botanical inventories of coastal natural areas where the species was historically known, or where suitable habitat existed, such as Sandy Hook (Stalter et al. 1996), Cape May Point State Park (Sutton et al. 1990), and Little Beach Island (Stalter 1994). Thus, by the end of the 1990s the last documented sightings of *A. pumilus* and *G. maritima* in New Jersey remained the specimens collected in 1913 in Ocean County and Deal in the 1800s, respectively.

In 2000, however, *A. pumilus* was rediscovered on New Jersey beaches during Piping Plover (*Charadrius melodus*) monitoring conducted by the U.S. Army Corps of Engineers (USACE) and USFWS. Ad hoc surveys of the twelve miles of northernmost beaches in the state resulted in more than 1,000 individuals found (Walsh 2000). The following year, the author was given the responsibility of expanding these surveys to other areas of the New Jersey coastline through the ONLM. Since previous surveys had been unsuccessful at locating any *A. pumilus* elsewhere in the state, more intensive methods were adopted in 2001. Rather than targeting specific sites based on historical presence, *a priori* judgments about the amount or quality of habitat present in a given locality, or other sampling criteria, the entire 118 miles of coastline in the survey area were covered, including any and all areas where ocean beach habitat existed.

With funding support from the USFWS (and USACE in 2002), these surveys were repeated in each of 10 consecutive years from 2001-2005 and 2007-2011. Because the shoreline environments are highly dynamic and constantly subject to change, the amount of suitable habitat present at a site may vary considerably between years (Barbour et al. 1985), and the species that inhabit them such as *A. pumilus* are typically capable of exceptional dispersal and seed banking capabilities in order to cope with these changing conditions (Weakley et al. 1996). Multiple surveys of this kind are therefore needed to effectively determine the presence, absence, or overall distribution of these species at a given site or region of the coastline. Snyder (1996), for example, suggested that ten consecutive years of research may be needed to effectively determine whether or not *A. pumilus* was actually present or absent in a given area.

Annual surveys of *A. pumilus* were also conducted by the USFWS, National Park Service (NPS) and USACE in the northernmost 12 miles of beaches in New Jersey each year since 2000 (Egger 2012), and by the author for all six rare beach species in 2001, 2002, and 2004. Surveys were expanded to included 15 miles of bayshore habitats on the Delaware and Raritan Bays in 2010 and 2011, and intact areas of all barrier island and some mainland bayshore habitats in 2009-2011. In all, these surveys provided a comprehensive assessment of ocean and bay beach habitats in New Jersey for these six rare beach plant species, the results of which are presented below. A comparison of these field survey results to the historical record for each species is also provided, as is some discussion of the importance and feasibility of conducting such comprehensive, systematic surveys for rare plants in order to better understand their status and distribution and advance their conservation and recovery in the future.

METHODS

Study Area

The New Jersey shoreline contains eight geological provinces (Nordstrom et al. 1977), seven of which were covered in these surveys. The entirety of the five oceanfront provinces was surveyed, including Northern Barrier Spit (Sandy Hook to Long Branch), the Northern Headlands (Long Branch to Bayhead), the Northern Barrier Islands Complex (Bayhead to Island Beach and Long Beach Island), the Southern Barrier Islands Complex (Little Beach Island, Brigantine Island, Absecon Island, Ocean City, Ludlam Island, Seven Mile Beach, Five Mile Beach, Two Mile Beach), and the Southern Headlands (Cape May). Sandy beaches in the Raritan Bay Province were surveyed from Perth Amboy to Leonardo, and in the Delaware Bay Province north to Reed's Beach. No beaches were surveyed along the Delaware River. The ocean beaches of New Jersey occupy four coastal counties (Monmouth, Ocean, Atlantic, Cape May), 48 municipalities, and numerous state, county, federal, municipal and non-profit protected areas. The surveyed portions of the Raritan Bayshore included Middlesex and Monmouth Counties, and 7 municipalities, and the surveyed portion of the Delaware Bayshore (Cape May County) included 3 municipalities.

Inventories for rare beach plants were conducted on 118 miles of sandy ocean beaches in New Jersey south of Seven Presidents' Park each year from 2001-2005 and 2007-2011 (major storms severely limited data collection in 2006). This amounted to approximately 91% of the state coastline. The remaining 12 miles of beaches to the north (Monmouth Beach, Sea Bright, Sandy Hook) were visited in 2001, 2002 and 2004, and portions of the adjacent Raritan (10 miles) and Delaware Bayshores (5 miles) were also surveyed in 2010 and 2011. The one mile of beach habitat at the Coast Guard Training Center on the west side of Cape May Inlet was surveyed only in 2008 by the author, but in other years by Coast Guard Staff (S. Egger pers. comm.). Intact remnants of sandy bayshore beaches on the barrier islands and mainland were covered from 2009-2011.

Survey Methods

The study species were *A. pumilus, P. glaucum, S. maritimum, O. humifusa, H. peploides,* and *G. maritima*. Nomenclature and identification follow Gleason and Cronquist (1991). All surveys were conducted by the author, with seasonal ONLM staff and interns assisting in 2008-2011. Additional observations of these species were also made by the NHP (D. Snyder), ONLM (R. Cartica), USFWS (W. Walsh, A. Scherer, S. Egger, C. Popolizio, S. Atzert, V. Turner), Conserve Wildlife Foundation of New Jersey (CWFNJ) (T. Pover), NPS (J. McArthur-Heuser, staff), USACE (D. Madera, M. Burlas), and others (L. Kelly, L. Wootton, J. Amoroso), the contributions of which are noted accordingly when appropriate.

Surveys were conducted in August each year, and were typically 8 to 10 days in duration. This period marks the point in the growing season of *A. pumilus* when the greatest numbers of individuals tend to be present in New Jersey, and is therefore optimal for population census activities. Surveys lasted from dawn to dusk (10 to 14 hours), with 7 to 25 miles of beaches covered each day. Surveys were occasionally preceded by preliminary visits to particular sites, from May through early July, and return visits were conducted on occasion from September through December in different years. Surveys for most of the shoreline proceeded from north to south in odd years (2001, 2003, etc.) and south to north in even years (2002, 2004, etc.).

The focal area of observation included all upper beach areas between the wrack line and seaward face of the foredune, or any other structure that otherwise delimited the landward extent of the beach surface (e.g., boardwalk, seawall, bulkhead). These areas have been variously referred to as "back beach," "upper beach," and "backshore" habitats (Burger 1996, Nordstrom et al. 1986, Breden et al. 2001), and typically contain sparse herbaceous beach vegetation dominated by *Cakile edentula,* along with other annuals such as *Chamaesyce polygonifolia,* and *Salsola kali* (Breden et al. 2001). Adjacent areas on the dune surface and higher beach areas are less prone to regular inundation and are typically dominated by the perennial grass *Ammophila breviligulata,* and other herbaceous species such as *Panicum amarum, P. amarulum, C. polygonifolia, Solidago sempervirens, Oenothera* spp., and *Triplasis purpurea.* Because of the low density of beach plants, and the small amount of habitat available (0-10 m) in most areas, it was possible to rapidly search and identify all plants occurring on the beach surface. Areas on the landward sides of the foredunes were not typically searched, except in the case of blowouts or other areas where annual beach vegetation was seen to occur behind them. However, the landward sides (and undersides) of boardwalks and artificial dunes were inspected when they were positioned on or over the back beach or lower foredune, and sufficient beach vegetation existed to warrant it.

The locations of all rare plants found were described according to nearby landmarks such as roads, structures, or access points, and GPS readings were taken for individuals or clusters in each year. Photographs were also frequently taken to provide record of species identifications, and/or document the conditions of individuals and threats to populations. Confirmations of species identifications and locations were made by NHP botanist D. Snyder in 2001, and voucher specimens were deposited at the Raritan Valley Community College Herbarium. Locational data were entered into a GIS database and results were submitted to the USFWS and NHP. The richness (# species) and persistence (# years found) of rare species found in each location was calculated to assess the relative suitability of different areas on the coast for rare beach plants. The survey results were also analyzed in terms of the cumulative number of new species locations found in each year in order to estimate the minimum number of surveys needed to capture 50%, 75%, and 90% of total locations found for these rare beach species. The average and maximum number of locations found each year and cumulative population sizes at each location (total # individuals found in all 10 years) were also described for comparison.

Historical Records

Rare beach plant occurrences found from 2001 to 2011 were compared to all known previous records for these species in New Jersey. The primary source of this information was herbarium specimen labels from the major regional herbaria, including the Chrysler Herbarium at Rutgers University, the Philadelphia Academy of Natural Sciences Herbarium, the New York Botanical Garden Herbarium, the Brooklyn Botanical Garden Herbarium, the Harvard University Herbarium, and in some cases, the National Herbarium at the Smithsonian Institution (D. Snyder, unpubl. data). Information gathered from each specimen label for this study included the date and location of collection and the name of the collector. Other information used in this study included published botanical literature and NHP field survey reports (NHP unpublished data, Snyder pers. comm.).

Published accounts of beach plants in New Jersey were reviewed for mention of additional rare plant locations not represented in the herbarium collections or NHP field surveys. These accounts included: Nuttall (1818), Torrey (1819, 1824), Rafinesque (1836), Kneiskern (1856), Willis (1874), Britton (1881, 1889), Harshberger (1900, 1901), Crawford (1908), LaWall (1910), Stone (1911), Chrysler (1930), Fender (1937), Small and Martin (1958), Martin (1959), Sutton et al. (1990), Stalter and Greller (1988), Stalter (1994), Stalter et al. (1996), Snyder (1996), and Snyder (2000).

Locations of historical records for these species were compared with those found during the field surveys to quantify and interpret changes between the historical and present distribution of each species.[3] To make them comparable, historical "locations" were grouped according to present day municipal boundaries, and in two cases (Cape May, Wildwood) municipal boundaries were lumped together, as well, to allow for better correspondence with historical data. Groupings of place names included Cape May (South and West Cape May, Sunset Beach, C. M. City, C. M. Meadows, C. M. Point), Wildwood (North Wildwood, W. Gables, W. Crest, Anglesea, Holly Beach, Five Mile Beach), Avalon (Peermont), Sea Isle City (Townsend's Inlet), Upper Township (Strathmere, Whale Beach), Ocean City (Peck Beach), Holgate (Tucker's Beach, St. Albans, Halfway House), and Bradley Beach (Ocean Park). All other "locations" follow modern municipal boundaries, with the exception of two townships whose irregular boundaries included segments of the coastline that were not contiguous and needed to be identified separately. These were Lower Township, for which the distinct place names Two Mile Beach, Fishing Creek, and Town Bank were tallied separately, and Long Beach Township, for which Spray Beach was tallied separately. Historical records that did not provide specific locations (e.g., "New Jersey") or were outside of the study area of this project were noted but excluded from the analyses. Some place names of beaches were used instead of the proper Township names, including Island Beach (Berkeley Township), Little Beach Island (Galloway Township), and Pork Island WMA (Egg Harbor Township).

The historical data were analyzed in terms of how many unique locations were documented for each species, and how many records (unique years of observation) existed for those locations, in order to eliminate redundant records of observations that were made in the same year at the same location. Data for all historical locations were categorized in terms of when they were last observed: 1800-1899, 1900-1979, and 1980-2000.[4] Results of the 2001-2011 surveys were then broken down for comparison into sites for which previous records existed and those which represented *de novo* locations. The relative increase or decrease in the number of known locations were noted accordingly.

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[3] Note that the word "historical" is not used here to refer to the status of a species or population (Snyder 1993), where a lack of recent observations makes uncertain its presence or absence in a given area, but merely the previous documentation of a population at any time in the past. Many of the "historical locations" recorded during this study, for example, were from the twenty years prior (Snyder unpubl. data), and the populations found in these cases should be considered to be more or less continuous with previous observations rather than representing a rediscovery of those populations.

[4] The boundaries of the respective periods are relatively arbitrary and made to simply categorize time since last observed; i.e., they do not necessarily reflect actual distinct periods of activity in collection, survey, or publication of beach species. Actual historic periods of noteworthy collection and field activity in New Jersey botany are briefly described in Snyder (2000), and may serve as a suitable basis for an alternative scheme of time periods for comparison. With abundant field survey and collection data generously shared by D. Snyder (unpubl. data) beginning in 1980, it made sense to separate this data set from the rest of the twentieth century (the records for which otherwise mostly predate 1940), as the populations observed in the more recent time period had a greater likelihood of being extant in 2001-2011.

RESULTS

2001-2011 Field Surveys - Extant rare beach plant populations were found in 33 different locations surveyed on the ocean coastline and 0 locations on the Raritan and Delaware Bays. In total, 77 occurrences[5] were observed for five of the six beach plant species (no *G. maritima* was found), including 0 in Middlesex, 25 in Monmouth, 17 in Ocean, 11 in Atlantic, and 24 in Cape May County. By species, *A. pumilus* was found in 28 locations in four counties, *P. glaucum* in 19 locations in four counties, *H. peploides* in 10 locations in four counties, *S. maritimum* in 10 locations in four counties, and *O. humifusa* in 10 locations in two counties (Atlantic and Cape May). In all, 317 records (unique locations + unique years of observation) of the five rare species were documented, including 103 *A. pumilus* records, 28 *S. maritimum*, 45 *H. peploides* and 84 *O. humifusa.* A summary of the initial and last dates of observation for each species by location is found in Tables 1-2.

Surveys by USFWS, USACE and NPS (Walsh 2000, Egger 2012), NHP (Snyder unpubl. data), CWFNJ (Todd Pover pers. comm.), and Amorosa (unpubl. data) contributed 28 of the unique records of observation for the focal species in 2001-2011, including 3 unique locations. Of these, *A. pumilus* was first discovered by D. Snyder (NHP) on Little Beach Island in 2001, and on Pork Island WMA by T. Pover (CWFNJ) in 2010. *Sesuvium maritimum* was discovered by D. Snyder in 2001 on Little Beach Island. No other unique locations (at the municipal level) were contributed by other authors; however, other records consisting of unique years of observation in these locations were found in some cases and are noted in Table 2.

Historical Records - Review of historical sources yielded 219 herbarium specimens, 29 NHP surveys, and 45 published observations for the six beach species studied (Table 3). Rare species were found in 36 locations on the ocean coast and 4 locations on the Raritan and Delaware Bays. For the six species total, there were 249 historical records in 89 cumulative locations,[6] including 2 occurrences in Middlesex County, 24 in Monmouth, 18 in Ocean, 15 in Atlantic, and 30 in Cape May. Thirty-nine historical species locations were first recorded in the 1800s, 34 in 1900-1979 and 18 in 1980-2000. Of these, 23 were last seen in 1800-1899, 39 in 1900-1979, and 27 in 1980-2000. These records included 12 locations of

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[5] The word "occurrence" here is being used to describe the cumulative # of locations found for all five species, such that multiple occurrences can exist in the same location (i.e., for different species). It does not correspond to the "element occurrence" delineations tracked by the NHP (e.g., NatureServe 2004).

[6] Seventeen collections and several published accounts were excluded from the historical analysis. One *A. pumilus* and four *P. glaucum* specimens from "New Jersey" were not specific enough to map. The Stone (1911) report of *A. pumilus* in "Cape May Court House" and the *O. humifusa* collection from Tom's River appear to be errors, being outside the established ranges of the respective species, and having little to no known suitable habitat (Snyder 1996, Snyder pers. comm.). Four *P. glaucum* localities were excluded due to their (apparent) occurrence outside the study area, including the "Egg Harbour" type locality (Nuttall 1818 PH), specimens from Camden (1897) and Island Heights (1892), and the "Waretown" locality reported in Stone (1911). Nine *S. maritimum* collections were also outside the study area (Arnold's Point, Salem County, and Kaighn's Point and Petty's Island on the Delaware River). The report by Stone (1911) from "Sherburn's" was excluded due to uncertainty of its location. Two unconfirmed sight records of *G. maritima* by Gil Cavileer (D. Snyder pers. comm.) at Holgate and Brigantine were excluded from the analysis due to their lack of sufficient documentation. Published accounts and field surveys were only used in the analysis if they presented novel places or dates of occurrence compared to the herbarium collections.

Table 1. Comparison of initial observation date in 2001-2011 to last known records for each species by county.

	Amaranthus pumilus		*Polygonum glaucum*		*Honckenya peploides*		*Sesuvium maritimum*		*Oenothera humifusa*		*Glaux maritima*	
County	**Last Record 1800-2000**	**First Record 2001-2011**	**Last Record 1800-2000**	**First Record** 2001-2011	Last Record 1800-2000	First Record 2001-2011	Last Record 1800-2000	First Record 2001-2011	Last Record 1800-2000	First Record 2001-2011	Last Record 1800-2000	First Record **2001-2011**
Middlesex	-	-	1906	-	-	-	-	-	-	-	-	-
Monmouth	2000	2001	2000	2001	2000	2001	1881	2001	-	-	1800s	-
Ocean	1913	2001	1987	2001	1986	2001	1993	2004	-	-	-	-
Atlantic	1884	2001	1888	2003	1998	2001	1990	2001	1987	2001	-	-
Cape May	1882	2001	1918	2003	1952	2001	1996	2003	1996	2001	-	-

Table 2. Historical (1800-2000) and current (2001-2011) locations of rare beach plant species in New Jersey, with first and last dates of observation. Dates with asterisk (*) indicate published account. Published accounts in parentheses indicate potentially redundant record, as many publications made use of earlier collected herbarium specimens. All dates from 1980-2000 are from D. Snyder (unpubl. data) unless marked with an asterisk, for published account.

		Polygonum glaucum				*Sesuvium maritimum*				*Oenothera humifusa*				*Amaranthus pumilus*				*Honckenya peploides*			
	Location	1800-2000		2001-2011		1800-2000		2001-2011		1800-2000		2001-2011		1800-2000		2001-2011		1800-2000		2001-2011	
		First	Last	First	Last	First	Last	First	Last	First	Last	**First**	**Last**	**First**	**Last**	**First**	**Last**	**First**	**Last**	**First**	**Last**
Middlesex	South Amboy	1883	1883																		
	Sayreville	1906	1906																		
Monmouth	Sandy Hook	1993	1993	2002	2010*	1881*	1881*	2004	2004					2000	2000	2001	2011*	1860	1996	2004	2009*
	Sea Bright	2000	2000*	2004	2010*									2000	2000	2001	2011*	2000	2000	2001	2001
	Monmouth Beach	2000	2000*	2004	2011*									2000	2000	2001	2010*				
	Long Branch	1877	(1910*)	2001	2010									1874	1899	2001	2011*	1819*	1819*		
	Deal					1800s	1800s											1865	2000		
	Asbury Park			2001	2011													1902	(1911*)		
	Ocean Grove			2002	2002																
	Bradley Beach	1877	1877	2001	2005											2001	2003				
	Avon-by-the-Sea	1889	1889					2002	2002							2002	2002	1891	1891		
	Belmar	1987	1987	2001	2010			2001	2001							2001	2011	1800s	1800s		
	Spring Lake	1884	1884	2004	2005											2004	2008				
	Sea Girt			2004	2010											2001	2009	1891	1891		
	Manasquan															2002	2002	1800s	(1911*)		
Ocean	Point Pleasant	1882	1882	2004	2004											2011	2011	1890	(1911*)		
	Bayhead			2003	2005											2002	2011				
	Mantoloking															2001	2005	1911*	1911*		
	Brick Township			2003	2003											2008	2009				

Ocean	Seaside Heights															2004	2005				
	Seaside Park																	1900*	1912		
	Island Beach	1987	1987	2001	2008			2005	2005					1913	1913	2001	2011	1913	1936	2001	2003
	Barnegat Light													1911*	1911*			1911*	1936		
	Long Beach Twp															2002	2002				
	Loveladies																	1937	1937		
	Ship Bottom																	1911*	1911*		
	Spray Beach																	1907	1907		
	Beach Haven	18??	18??															1888	1888		
	Holgate			2008	2008	1907	1993	2004	2010					1908	1908	2001	2011	1960s	1986	2001	2010
	Tucker's Island													1802	1802						
Atlantic	Little Beach Isl.					1987	1987	2001	2010							2001	2001	1987	1989*	2001	2010
	Brigantine			2003	2003	1971	1990			1973	1973			1860	1860	2001	2008	1935	1996	2001	2011
	Atlantic City	1888	1888			1871	1879					2002	2004	1859	1884	2008	2008	1870	1870		
	Longport					1910*	1910*			1987	1987	2001	2010					1910	1910*		
	Pork Island					1987	1987	2007	2010							2010	2011	1987	1987		
Cape May	Ocean City	1890	1912	2004	2010	1882	1916	2004	2004	1896	1987	2001	2010	1876	1876	2003	2011	1907	1916		
	Upper Twp.			2009	2009	1996	1996			1996	1996	2001	2010			2001	2005	1935	1935	2003	2008
	Sea Isle City					1937	1937					2001	2010	1882	1882	2004	2009	1887	1937	2004	2004
	Avalon			2003	2003	1912	1912			1901*	1901*	2001	2010			2003	2003	1908	1935		
	Stone Harbor					1935	1935	2003	2009			2009	2010					1901*	1907	2001	2001
	Wildwood	1895	(1911*)			1895	1936			1891	1986	2001	2010					1894	1936		
	Two Mile Beach	1918	1918			????	1918			1952	1952	2001	2010			2003	2004	1952	1952	2001	2004
	Cape May	1874	(1911*)			1869	1993	2011	2011	1842	1980	2001	2011			2003	2003	1911	1926		
	Fishing Creek																	1937	1937		
	Town Bank																	1937	1937		

Table 3. Historical records for rare beach plant species in New Jersey. The table shows the number of herbarium specimens, published accounts and NHP field surveys that identify the locations of rare beach plants in New Jersey. Listed are the total number, the number that presented novel records (unique locations + unique years collected/observed), and the number of unique locations added from each source.

	Specimens			Literature			NHP Field Surveys[1]			Total Known Locations
Species	# Records	Unique Records	Unique Locations	# Records	Unique Records	Unique Locations	# Records	Unique Records	Unique Locations	
A. pumilus	25	24	8	8	2	1	3	3	3	12
P. glaucum	36	30	13	4	3	0	5	5	5	18
H. peploides	48	48	27	21	10	4	6	6	3	34
S. maritimum	58	49	12	6	3	2	8	8	2	16
O. humifusa	51	51	4	4	1	1	5	5	3	8
G. maritima	1	1	1	2	0	0	2	0	0	1
TOTAL	221	203	65	45	19	8	29	27	16	89

A. pumilus, 18 of *P. glaucum*, 34 of *H. peploides*, 16 of *S. maritimum*, 8 of *O. humifusa* and 1 of *G. maritima*.

Comparing the field survey results to historical records, 44 (57%) of the 77 total occurrences found in 2001-2011 were from areas where populations had been documented historically, representing a rediscovery or confirmation of these species in 49% of the 89 known historical locations overall. Of the 44 rediscovered occurrences, 9 were last observed in 1800-1899, 13 in 1900-1979, and 22 in 1980-2000 (Figure 1, Table 2). The 33 *de novo* species locations found in 2001-2011 represented an increase of 37% relative to the 89 historical occurrences known for these species overall. The 317 survey records from the 2001-2011 surveys were 27% greater than the 249 records documented from 1800-2000.

Observed populations of rare beach plants were typically very small in size and highly ephemeral in most locations (Table 4). With the exception of *O. humifusa*, the majority of locations found for each species in 2001-2011 supported less than 10 individuals *total* in all ten years studied, and only 10-30% supported 100 individuals or more. Except for *O. humifusa*, populations were observed for an average of only 3-5 years at each location and 30-60% of locations were observed in only one year, depending upon the species (Table 4).

In general the annual species (*A. pumilus, P. glaucum, S. maritimum*) tended to be more ephemeral than the perennial species. These rarely persisted for three consecutive years or more in a given location, but would frequently return after a year or more of absence, due either to seed banking or recolonization of sites by dispersal. Similarly short-lived populations of the perennial species, *H. peploides* and *O. humifusa*, were also found in some cases, usually on lower beach surfaces that were exposed to storm surges, erosion, or human activities, such as off-road vehicle use and mechanical beach raking. In most cases, however, these species did not return after their local disappearance during the time of

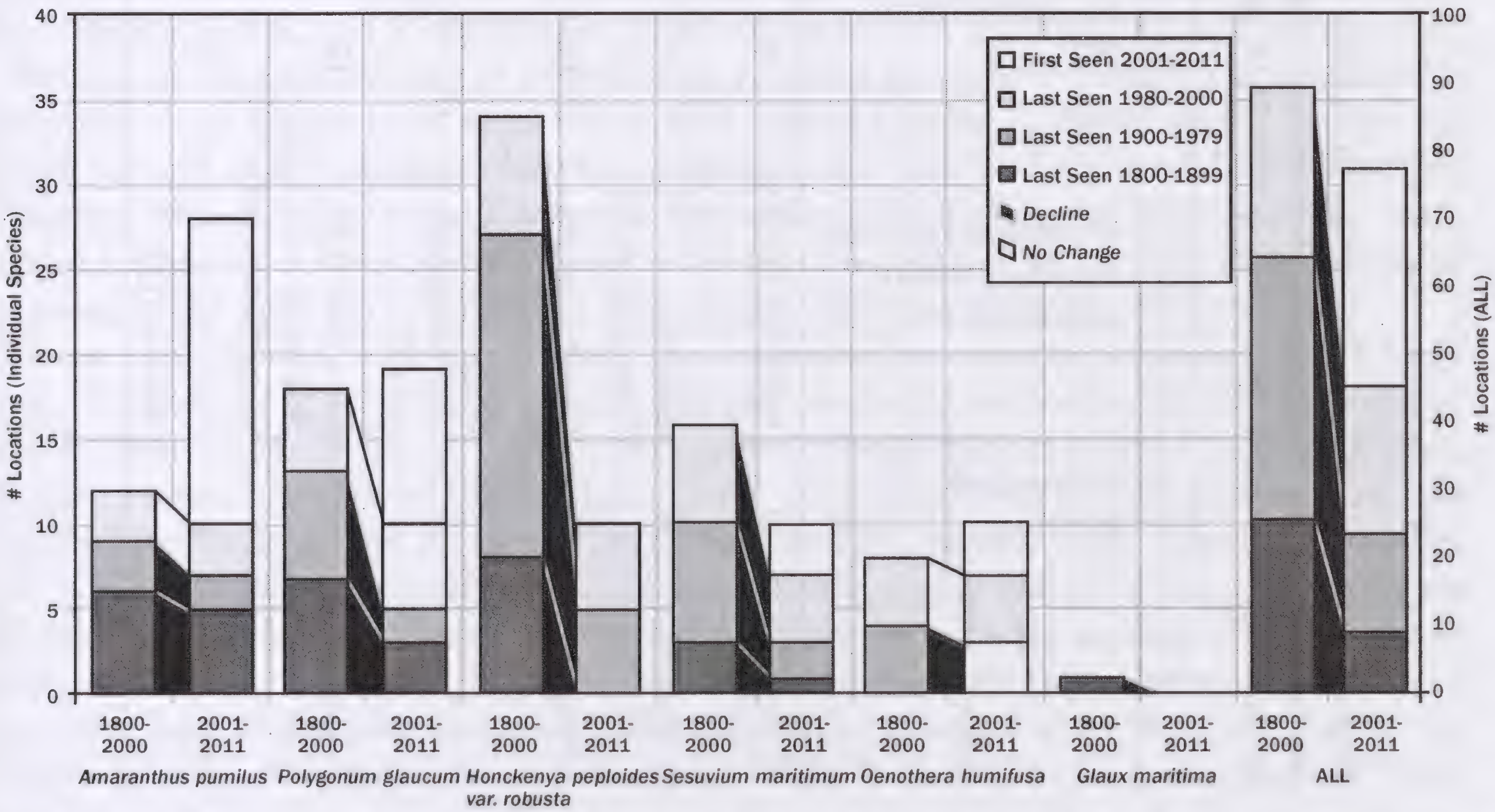

Figure 1. Comparison of current (2001-2011) and historical (1800-2000) locations of rare beach plant species in New Jersey.

Table 4. Summary findings of 2001-2011 surveys for rare beach plant species relative to historical records. Summary of results, including comparison of found # of historical, *de novo*, and total locations in 2001-2011 to # historical locations (1800-2000), frequency of historical specimen collections and observation in 2001-2011, persistence, and cumulative population size.

	Historical Records		2001-2011 Surveys								
Species	# historical locations	Historical locations w/ >2 specimen collections	# locations 2001-2011	# found at historical locations	% historical locations found	# found at *de novo* locations	% increase in # known locations (*de novo* vs. hist.)	% Δ in # locations (2001-2011 vs. historical)	Avg. (max.) # locations found/yr in 2001-2011	Avg. # years found at each location	Σ total individuals found/location in 2001-2011
A. pumilus	12	Atlantic City (16)	28	10	83%	18	164%	150%	12 (17)	4	74% ≤10 21% ≥100
P. glaucum	16	A.C. (6); Long Branch (5)	19	10	63%	7	50%	19%	3 (6)	3	83% ≤10 13% ≥100
H. peploides	34	Ocean City (4); Peermont (4); Brigantine (3); Wildwood (8); A.C. (5)	10	10	29%	0	0%	-71%	4 (7)	5	70% ≤10 10% ≥100
S. maritimum	16	Cape May (12); Wldwd. (6); A.C. (5); Brig. (5); O.C. (5);	10	7	44%	3	19%	-56%	3 (4)	3	50% ≤10 30% ≥100
O. humifusa	8	C.M. (28); O.C. (7); Wldwd. (12);	10	7	88%	3	38%	25%	9 (10)	10	100% ≥100

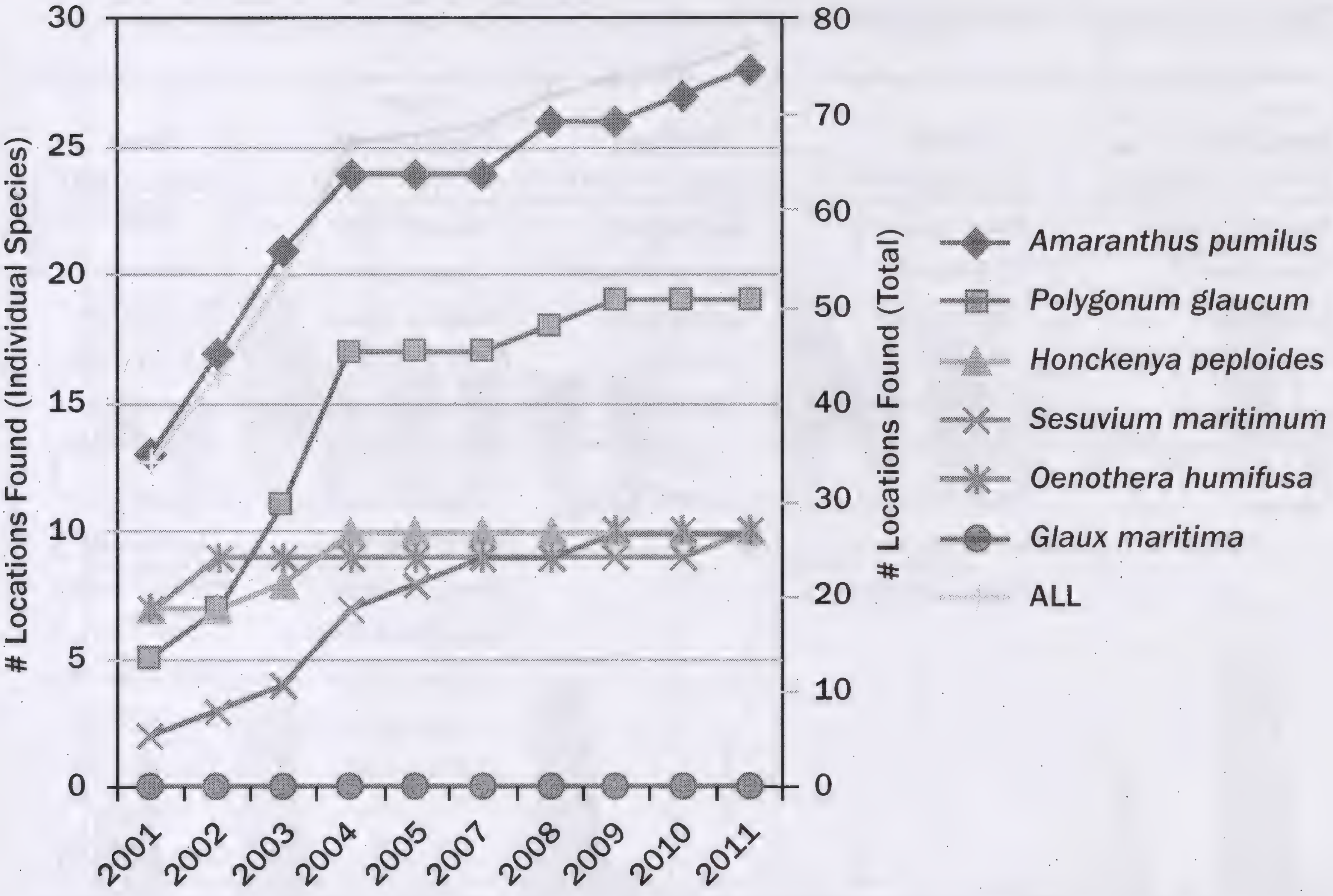

Figure 2. Cumulative number of new rare plant locations documented in each survey year from 2001-2011.

this study. More secure populations of *O. humifusa* were typically found at slightly higher elevations in the foredunes, *H. peploides* in the upper beach on broad overwash flats and accreting island tips, and *S. maritimum* in interdunal swales, salt pans, and salt marsh edges.

Because of the ephemerality of populations, repeated surveys were needed to successfully document these species in all areas where they existed (Figure 2). Based on the five species found, surveys must have taken place for a minimum of 7 years (4-7 yrs. for individual species) to capture 90% of the locations discovered during the 2001-2011 survey period. Surveys were needed for at least 4 years (2-4 years for individual species) to capture 75% of documented locations, and 2 years (1-3 years for individual species) to capture 50% of locations.

Greater numbers of rare beach plant species tended to occur in locations where large areas of protected beach habitat existed, and also tended to persist for greater amounts of time in these places (Table 5). Only four locations (Sandy Hook, Island Beach State Park, Holgate Natural Area, Little Beach Island) had a majority (3-4) of the rare beach species present for the majority of the survey years (5+ years) on average. These areas are 3-10 miles long and are largely protected from mechanical beach raking and (to a lesser extent) from off-road vehicle use. Nine locations had 2-3 species present for an average of four years or more, indicating relatively high quality habitat for these species compared to other areas of the coast. Each of the nine locations had either large protected areas within it (e.g., Seven Presidents' Park, Brigantine Natural Area), or USFWS-approved beach management plans (e.g., Upper Township) to restrict uses of mechanical raking devices and off-road vehicles. The seven locations listed in Table 5 as "Moderate" habitat also had sizeable protected areas or beach management plans, but many had large areas of unsuitable habitat, due to

Table 5. Rankings of locations based on rare beach species richness and average persistence.

Very High (3-4 spp., 5+yrs)	**High** (2-3 spp.,4+yrs)	**Moderate** (2-3 spp., 2-4 yrs)	**Low** (2 spp. <2 yrs, or 1 spp., 1+yrs)	**None** (0 spp., 0 yrs)
Sandy Hook*‡	Long Branch†‡	Sea Bright†‡	Asbury Park	Deal
Island Beach*	Belmar†	Monmouth Beach†‡	Ocean Grove	Allenhurst
Holgate*	Brigantine†	Spring Lake†	Bradley Beach	Loch Arbour
Little Beach Island*	Ocean City†	Sea Girt†	Avon-by-the-Sea	Dover Twp
	Upper Township†	Bayhead†	Manasquan	Lavallette
	Sea Isle City†	Avalon†	Point Pleasant	Seaside Park
	Stone Harbor†	Pork Island WMA*	Mantoloking†	Barnegat Light†
	Two Mile Beach*		Brick Township	Loveladies
	South Cape May†		Seaside Heights	Harvey Cedars
			Long Beach Twp	Surf City
			Atlantic City	Ship Bottom
			Longport	Beach Haven
			Wildwood†	Ventnor City
				Margate
				Cape May City

* - protected natural areas; † – contains significant parks and/or areas protected for rare beach plants or nesting birds; ‡ – includes data from USFWS, USACE and NPS (Egger 2012) and Amorosa (unpublished data)

narrow, erosive beaches, encroachment of perennial dune vegetation, and/or incompatible land uses. Areas with low habitat availability tended to lack substantial areas of suitable habitat, typically due to land use activities such as mechanical beach raking and/or off-road vehicle use, as did most municipalities where no rare species were found. The exception to this pattern is Barnegat Light, which had large areas of available beach habitat and is immediately adjacent to Island Beach State Park. The extensive jetty at Barnegat Inlet may have prevented the successful longshore transport of propagules to the site.

Species Accounts

Amaranthus pumilus was found in 28 locations in all four coastal counties in 2001-2011, with the greatest number of locations found in Monmouth (10) and Ocean (8) Counties (Figures 3-4). These findings included 10 of 12 known historical locations, 7 of which had not been observed since 1913 or earlier. The other 3 represented the continuous presence of those locations discovered in 2000 in Sandy Hook, Sea Bright and Monmouth Beach (Walsh 2000); the last record prior to 2000 in Monmouth County dates to a collection made in Long Branch in 1899. The 2 historical locations that did not support *A. pumilus* populations in 2001-2011 were the type locality at Tucker's Island (Rafinesque 1836) and the B. Long report for Barnegat City, Long Beach Island (Stone 1911). Tucker's Island no longer exists in New Jersey, having disappeared by the 1930s due to coastal erosion (Salvadove and Bucholz 1993). In 2002, a small population of *A. pumilus* was found near the

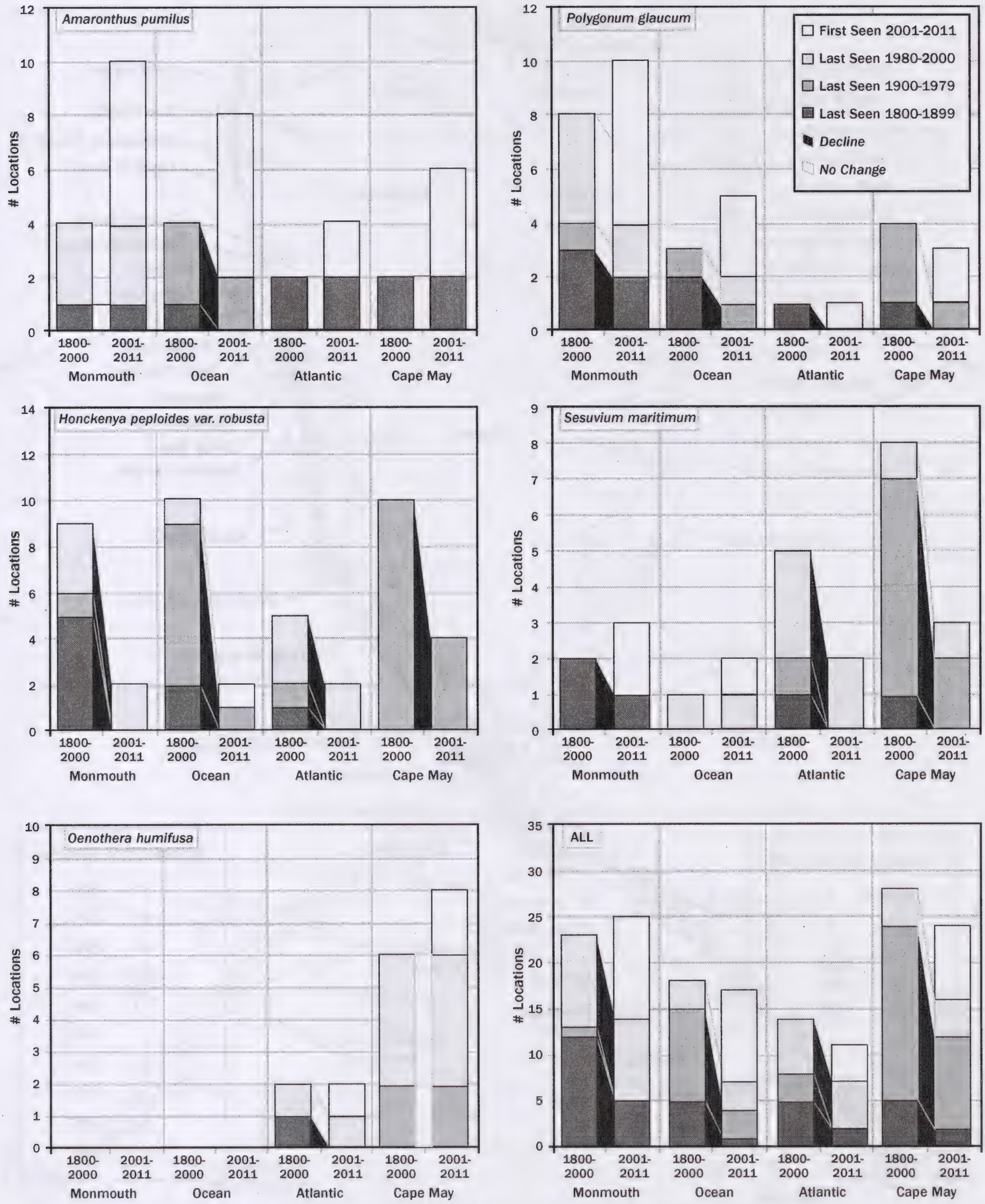

Figure 3. Comparison of current (2001-2011) and historical (1800-2000) locations of rare beach plant species in New Jersey by county.

historical Barnegat City location, but several miles to the south in Long Beach Township. The majority of historical specimen collections were from Atlantic City (15), with only 1-2 collections from each of the other historical locations. In contrast, only one *A. pumilus* individual was observed in Atlantic City in 2001-2011.

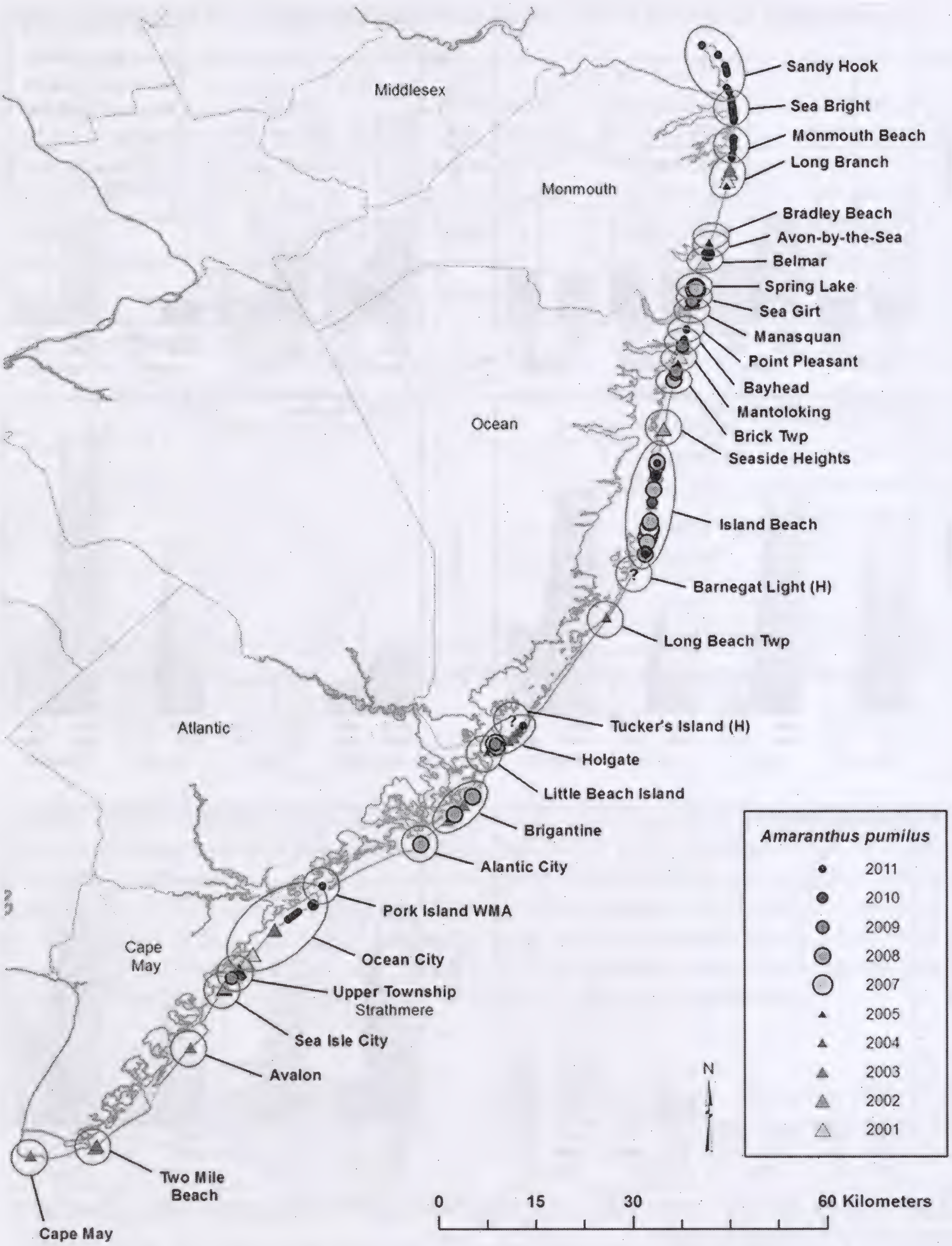

Figure 4. Current and historical (H) locations of *Amaranthus pumilus* in New Jersey.

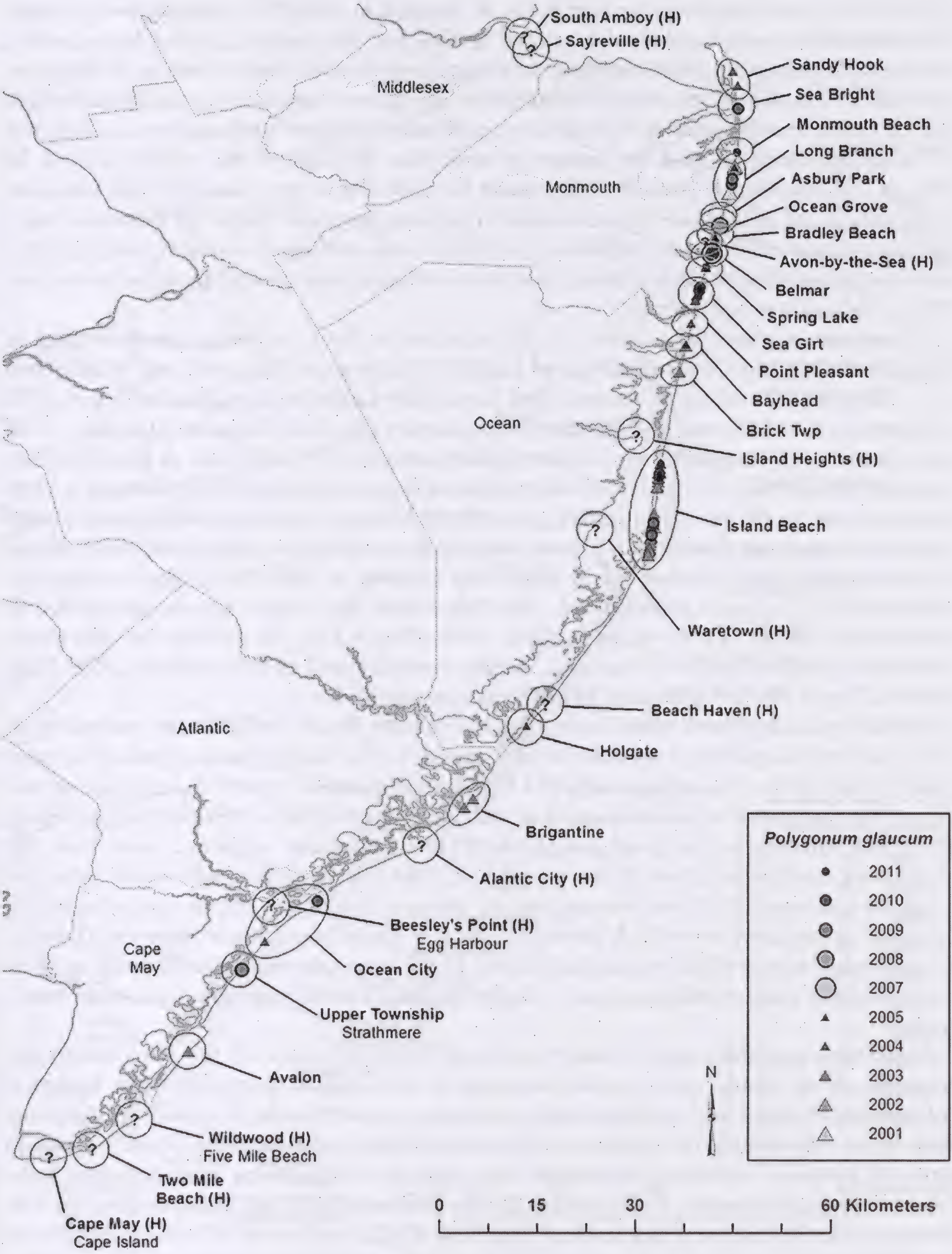

Figure 5. Current and historical (H) locations of *Polygonum glaucum* in New Jersey.

The 18 *de novo* locations discovered for *A. pumilus* in 2001-2011 represent an increase of 164% in the total number of locations known for the species in New Jersey, and a considerable expansion of its documented range along the full ocean coastline of the state, from Sandy Hook to Cape May Point (historically documented from Long Branch to Sea Isle City). For most locations, *A. pumilus* populations were small and ephemeral, with only 10 locations having *A. pumilus* present in more than five out of ten years (Table 4). In 50% of the locations, *A. pumilus* was present for only one or two years, 74% of locations never supported more than 10 individuals in a given year, and 18 (64%) locations had a cumulative *total* of 10 or less individuals in the 10 years studied. In contrast, only 6 (21%) contained more than 100 individuals in ten years total, and only Sandy Hook had more than 100 individuals/year on average.

Polygonum glaucum was found in 19 locations in four counties, but primarily in Monmouth (10) and Ocean (5) (Figures 3 and 5). The species was confirmed in only one of five historical locations in Atlantic and Cape May Counties, compared to 9 out of 11 in Monmouth and Ocean. The two northern counties also had the greatest number of *de novo* locations (6) compared to the two southern counties (3). In all, the *de novo* findings represent an increase of 50% in the total number of locations known for *P. glaucum* in New Jersey relative to the historical record. In terms of historical specimen collections, 6 were collected from Long Branch and 5 from Atlantic City, with 2 or fewer at other locations. No populations were discovered in Middlesex County in 2001-2011, where it was last collected in 1883 (South Amboy) and 1906 (Sayreville), but further surveys are needed as these reaches were only surveyed in three years. This is also the case for the Waretown and Island Heights historical locations, which were surveyed in only one year. The "Egg Harbour" type locality at Beasley's Point was not surveyed.

Excluding Sandy Hook, Sea Bright, and Monmouth Beach (which were not surveyed each year for this species), only 2 out of 16 locations (13%) had *P. glaucum* present in more than five out of the ten survey years, and 56% had *P. glaucum* present in only one or two years. Populations were also very small at each location, with 83% of locations supporting 10 or less individuals in a given year. Only 2 (13%) locations contained more than 100 individuals total in ten years of study, and 12 (75%) had 10 or less individuals total. No locations contained ≥100 individuals/year on average. Individuals of this species regularly occurred in conjunction with *A. pumilus.* The few larger populations observed (Belmar, Long Branch) appeared to be in slightly higher beach areas that were more exposed to wind and contained coarser sediments and a higher degree of shell fragments than other beach areas.

Honckenya peploides var. *robusta* was found in 10 locations in the four oceanfront counties, all of which were known locations of the species, primarily from historical collections (Figures 3 and 6). Historically, this species was by far the most widely occurring, with more than double the number of locations of the next most widespread species. In terms of historical collection frequency, the majority of specimens were collected from Ocean City (4), Peermont (4), Brigantine (3), the Wildwoods (8), and Atlantic City (5). The decrease from 34 historical locations to 10 in 2001-2011, a decline of 71% in the number of known locations for this species, indicates a tremendous decline in the range of the species. The populations found in 2001-2011 included 0% of those last observed in 1800-1899, 24% of those last seen in 1900-1979, and 63% of those found in 1980-2000.

Significant declines were observed not only in comparison to historical records, but in the number and size of *H. peploides* populations seen within the ten-year field survey window,

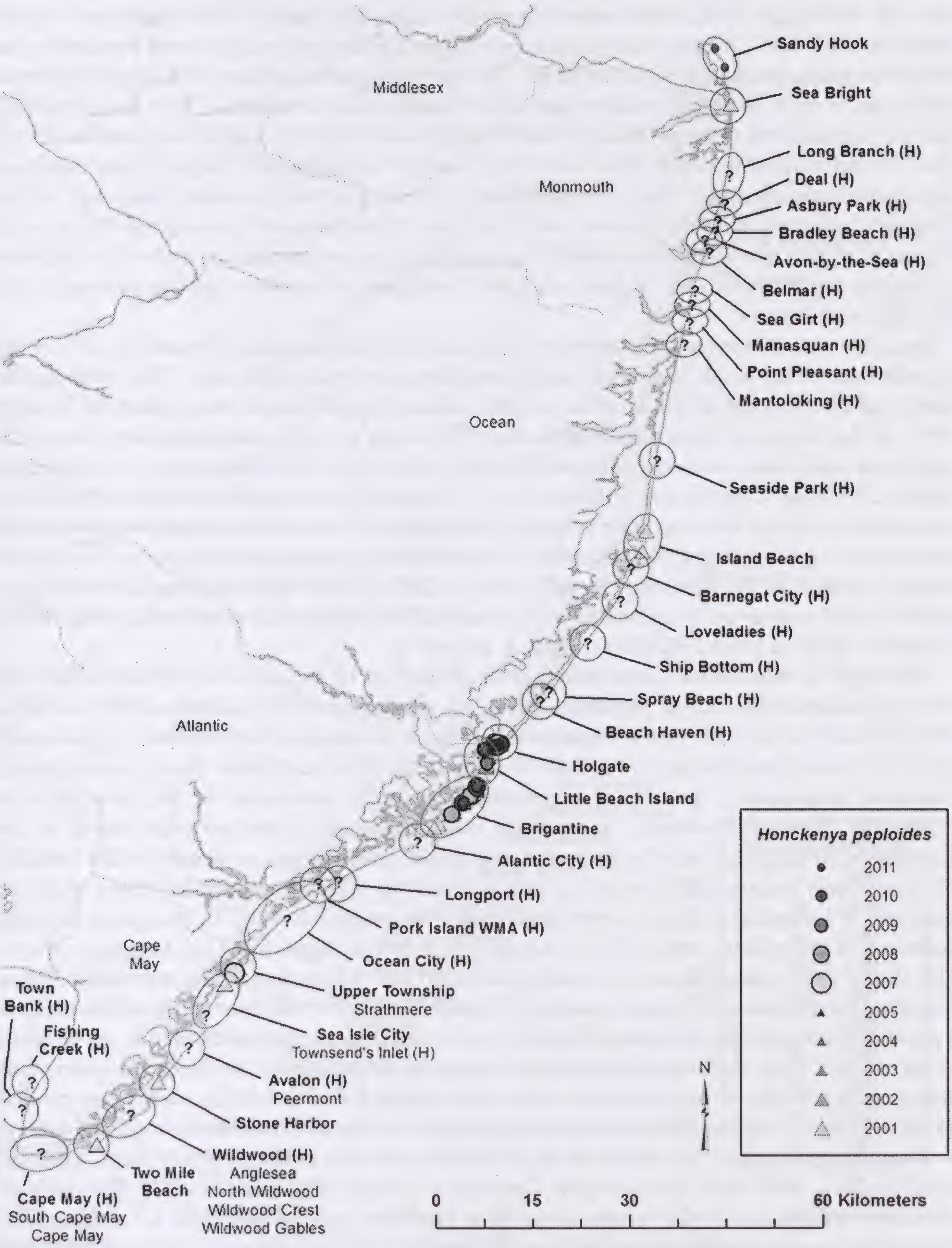

Figure 6. Current and historical (H) locations of *Honckenya peploides* in New Jersey.

as well. Although 8 locations were observed (excluding Sandy Hook and Sea Bright) between 2001-2007, with as many as 6 appearing in a given year, only 3 were present in the last three years of study, from 2008-2011. The rest were lost to erosion of habitat by storms and impacts from off-road vehicles and beach maintenance activities. Three locations had sizable populations (greater than 50 individuals) in 2001-2011, but all declined to fewer than 20 individuals by 2010 (two had fewer than 10 individuals). Despite these declines, populations did appear to be more persistently present in each location compared to the "fugitive" annuals described above, with five out of ten years of persistence on average. This is no doubt due to the perennial life cycle of the species and the situation of individuals at slightly higher elevations on the beach and foredunes, where they are less susceptible to the effects of storms.

Sesuvium maritimum was observed in 10 locations in four counties (Figures 3 and 7), with populations being more numerous in the southern portions of the state. This reflects the historical distribution of the species, as well, although populations were observed in only 44% of the historical locations in this study. In terms of collection frequency, historical specimen collections were concentrated in Cape May (12), the Wildwoods (6), Brigantine Island (5), Ocean City (5), and Atlantic City (5). *De novo* locations discovered in 2001-2011 were found only in the northern counties and appeared to be more numerous there than in the past, representing a 19% increase in the number of known locations for the species overall, relative to the historical record. Only 1 (25%) of the historical locations last seen in 1800-1899 supported populations in this study, 29% of those last observed in 1900-1979, and 66% of those from 1980-2000 (Table 2, Figure 3).

Although *S. maritimum* populations were found in 10 locations from 2001-2011, the average number of locations present in any given year was only 3 (maximum of 4) and 60% were present for only 1-2 years. Populations in those six locations were not only ephemeral, but small in size, numbering fewer than 50 individuals (five were fewer than10 individuals). The four persistent populations, in contrast, typically numbered in the hundreds or thousands. Populations tended to be much more stable and abundant (numbering in the thousands) in salt pans, interdunal swales, and upper marsh edges, compared to the handful of individuals occasionally found on ocean beaches. This is interesting given that the majority of historical collections were collected from beach habitat (11), compared to those collected in interdunal swales (3) or salt pans and marsh edges (6). This suggests either a bias in the sites visited (beaches vs. other habitats) and where specimens were collected, a broader interpretation of what constituted "beach" habitat by those making collections, or a possible change in the character of beaches, such that they are less suitable to *S. maritimum* in the present than they were historically. Given the large number of historical collections and present survey results from these other (non-beach) habitats, further surveys are needed of these areas to confirm the overall status and distribution of *S. maritimum* in New Jersey.

Oenothera humifusa was observed in 10 locations in two counties (Cape May, Atlantic) in 2001-2011, with 80% occurring in Cape May County (Figures 3 and 8). The bulk of historical collections for the species come from just three general locations: Cape May (28), where historical records date to 1842, the Wildwoods (12), and Ocean City (7). All but one historical location were relocated in this study (Brigantine), and three *de novo* locations were discovered, increasing the number of known locations for the species by 38% relative to the historical record. Populations were typically persistent in the foredune environments,

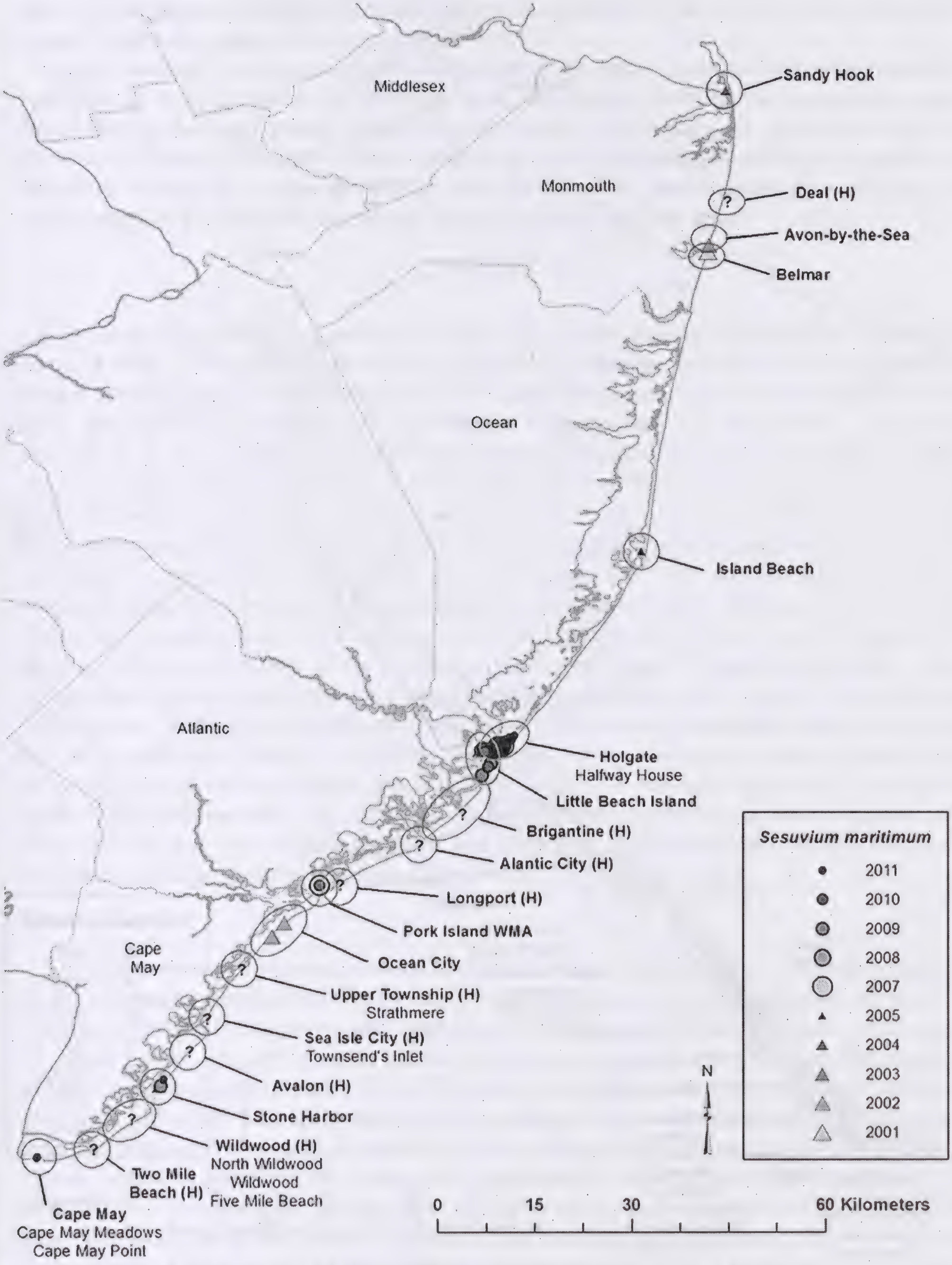

Figure 7. Current and historical (H) locations of *Sesuvium maritimum* in New Jersey.

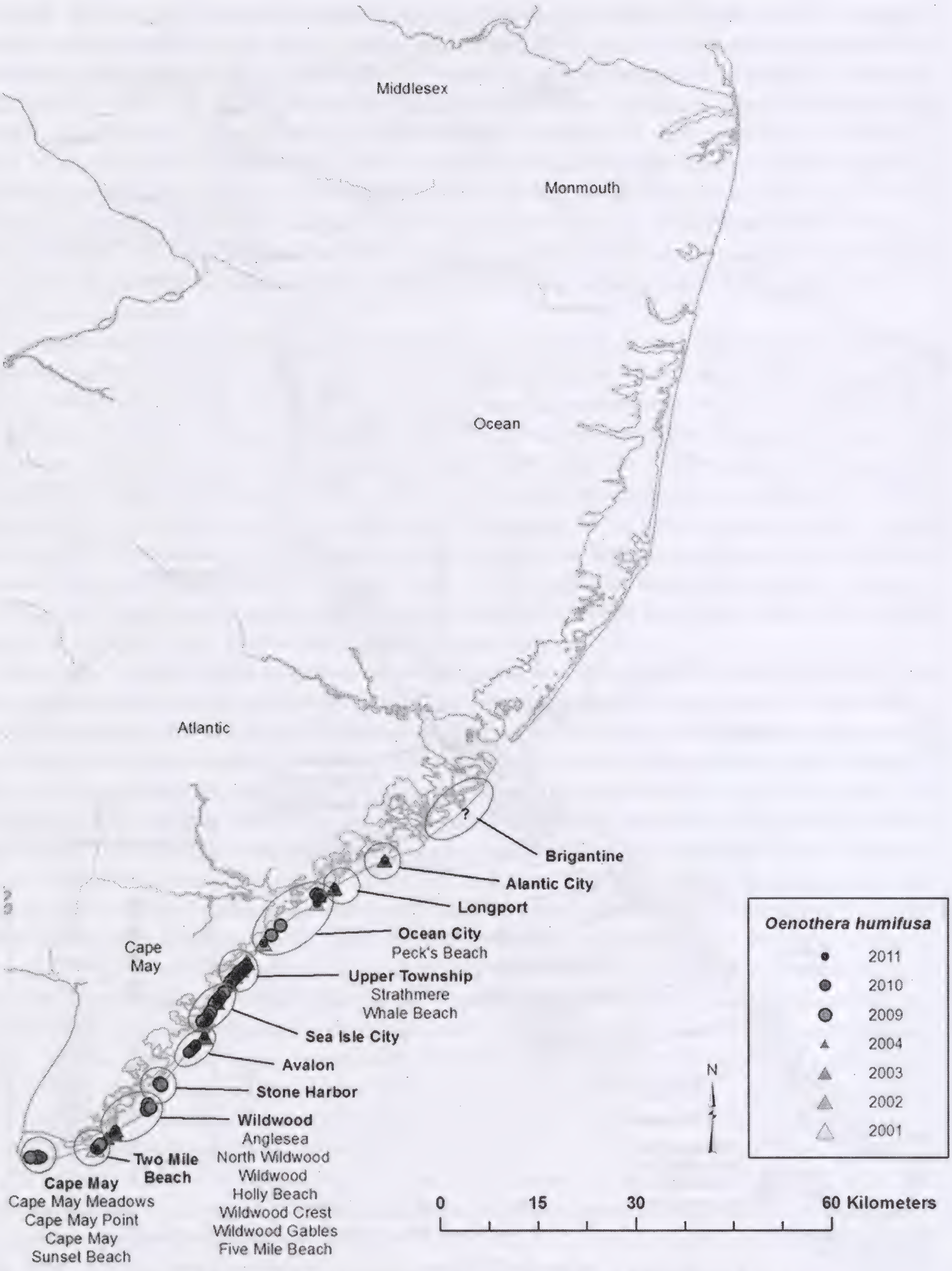

Figure 8. Current and historical (H) locations of *Oenothera humifusa* in New Jersey.

above the influence of regular tides and storms. In contrast, on the beach surface this species would frequently colonize but not persist.

Glaux maritima was historically documented in just 1 location, with the specimen collected by A.H. Smith in the 1800s in Deal, Monmouth County. No populations were found during field surveys in 2001-2011. As with *S. maritimum, G. maritima* is known to occupy a variety of other habitats aside from ocean beaches, and additional surveys are therefore needed of peripheral habitats such as salt pans, wet depressions in dunes, and marsh edges to confirm the overall status of the species in New Jersey.

Discussion

The results of these studies generally confirm three basic points: (1) the rarity and tenuous status of these six beach plant species in New Jersey, (2) the effectiveness of the comprehensive survey methods used to find them, and (3) the need for greater protection of beach habitats from incompatible land uses to further their conservation. The exhaustive, consecutive searches of nearly all areas of potential beach habitat in the state yielded a much higher number of populations of these species than was thought to exist, or would otherwise have been found had less intensive survey methods been adopted. Few to no extant populations of the six rare beach plant species were known in New Jersey prior to these surveys, and few were expected to be found given the extent to which most beaches in the state are presently impacted by coastal development, hard shoreline stabilization, mechanical beach raking, off-road vehicles, and other recreational uses. While the majority of beaches were indeed heavily impacted by these activities, occurrences of the rare beach plant were found on numerous beaches where these activities took place, only in the small fragments of habitat that remained on the margins of these uses. However, populations in these areas tended to be exceedingly small, short-lived, and of questionable long-term viability. Given that larger and more persistent populations were only found in areas where much larger amounts of contiguous habitat were present both within and between the locations studied, greater protection of beach habitat from incompatible land uses at both the local and landscape level is needed to better secure the long-term viability of these species in New Jersey.

Species Status

The field surveys conducted from 2001-2011 effectively reestablished the presence of five of the six species studied in 90% of the locations in which they were known to occur in New Jersey at the county level, and approximately 50% of the municipalities overall, many of which had no records of these species for more than one hundred years. The presence of these species across so much of the New Jersey shoreline was a positive and unexpected outcome, and offers a unique opportunity to advance the conservation of these species in the state. Such efforts are greatly needed, given the fragile status of many of the populations found. While *A. pumilus* and *P. glaucum* were found in many municipalities (28 and 19, respectively), for example, the majority of locations supported a cumulative total of less than 10 individuals in the ten years of study, and most persisted for only one to two years. Populations of these species were persistent and numbered in the hundreds on an annual basis in only one to three locations. The other species (*H. peploides, S. maritimum* and *O.*

humifusa) were found in far fewer locations overall, although often in larger numbers, and no populations of *G. maritima* were found at all.

With the exception of *A. pumilus* and *O. humifusa*, most species exhibited substantial contractions in their current distribution compared to their historical ranges, disappearing from over 50% of the places where populations were historically known to occur. For most species, these losses occurred primarily in the southern Atlantic and Cape May Counties, where the majority of historical collections were made. By far the most dramatic declines were evident with *H. peploides*, both in comparison to the historical record (71% decline), as well as during the present ten years of field study. This species was found to be extant in only 10 of 34 historical locations, and no *de novo* locations were found. While more than 1000 individuals were found across ten populations from 2001-2005, the numbers dwindled to less than 30 plants in four locations by 2007-2011. These declines appeared to be due to a combination of severe erosion and incompatible land uses, which caused existing populations to diminish while simultaneously inhibiting the successful colonization and establishment of populations at other sites. If the current trends continue, the coming years may well bear witness to the disappearance of *H. peploides* from the New Jersey coastline entirely.

Habitat Availability

For all six rare beach plant species, the primary limiting factor to their persistence and recovery in New Jersey appears to be the lack of large, contiguous areas of available habitat, due to existing patterns of coastal development, shoreline stabilization, and incompatible land uses. The only areas where the majority of rare beach plant species studied were found to occur in the majority of years on average were those locations with large areas of contiguous habitat and where these human activities tended not to occur. In general the greatest persistence and diversity of these species were exhibited in the three remaining areas of the New Jersey coastline where 8-10 miles of contiguous protected beach habitat are present: Sandy Hook in Gateway National Recreation Area (10 miles), Island Beach State Park (10 miles), and Holgate through northern Brigantine (8 miles), which exists within Edwin B. Forsythe National Wildlife Refuge and Brigantine Natural Area. This suggests that such large areas of protected habitat may be needed to secure the long-term viability of these species in a given area. In such dynamic coastal environments, which are constantly changing due to processes of sediment accretion and erosion, the regional persistence of populations likely depends upon their ability to colonize adjacent or other areas of suitable habitat when local populations are destroyed. The ability of these species to do so is likely impeded by incompatible land use practices that fragment beach habitats with large areas where conditions are made unsuitable for colonization, establishment, and/or persistence of populations.

Outside of the three large areas of protected shoreline in New Jersey, the rare plant species studied seemed to be relatively abundant in townships which contained substantial areas of parks and preserves and/or where collaborations among the federal, state, and/or local officials resulted in the implementation of beach management plans to protect all or a portion of the beaches for rare beach plants and associated beach nesting birds from incompatible land uses such as mechanical beach raking and off-road vehicles. The relatively high abundance of rare beach plants in these areas compared to others attests to the effectiveness of these efforts and suggests that an expansion of these measures to other areas could greatly enhance the viability of these species in other parts of the state. It may be that the long-term viability of these species in New Jersey will be entirely dependent upon the successful expansion of these types of measures to other areas, and upon the finding of a better compromise between the needs of these species for sufficient amounts of habitat to survive and the interests of the people that are also using them.

Survey Methodology

With successful rediscovery of five of the six rare beach species in nearly 50% of the historical locations and large numbers of *de novo* populations found, the systematic field surveys resulted in a significant expansion of our knowledge of these species in New Jersey. The ten years of intensive field study resulted in 27% more rare plant records (unique locations + unique years of observation) than the nearly 200 years of historical records prior, and increased the number of known locations for these species by 37%.

Many of the populations found in these field surveys occurred in areas that did not correspond with prior notions of what constituted areas of "suitable" habitat, or locations where the species was thought likely to occur based on overall patterns of land use. Individuals were frequently found in marginal fragments of habitat less than a meter wide, on beaches that were otherwise heavily developed, stabilized, raked, overridden, and/or populated by recreational beach-goers. This suggests the limits of our *a priori* understanding in determining habitat quantity or quality at a given site based on generalizations about land use, and the need to enter into such studies with the least amount of survey bias as possible. Far fewer rare beach plant populations would have been documented in this study had less intensive survey methods been adopted (e.g., searching only historical sites, areas presumed to have large amounts of habitat, and/or lower human population or recreational uses, etc.), and the resulting impression of the status and distribution of these species in New Jersey would therefore have been much less detailed and accurate. This has implications for the conservation of these species, as protection or management of populations is ultimately dependent upon obtaining accurate, detailed knowledge of their whereabouts, population trends over time, and an understanding of the relevant biological and environmental variables in order to interpret these trends.

The results of this study also suggest that consecutive or recurring surveys are also needed to effectively document populations when the target species and/or the habitats they occupy are ephemeral, dynamic or "fugitive" in nature (i.e., possessing of exceptional dispersal and/or seed banking capabilities). At least four to seven years of statewide surveys were needed to capture 90% of the rare beach plant populations that were found in the ten years of surveys from 2001-2011.

One of the limitations of the present study is that it relied primarily on a single annual census to document species populations, when surveys may be needed *within* each growing season to successfully capture the total number of locations at which the species were present in a given year and/or the number of individuals present in a population. In several cases where multiple surveys were conducted within the same year, some individuals of *A. pumilus* and *P. glaucum* were observed that did not persist until the time of the census in August. Such early-season mortality was reported in North Carolina (Hancock 1995) and in northern New Jersey (Walsh 2002), and in transplanted individuals in North Carolina (Rosenfeld 2004). In a small number of cases, individuals were also observed to germinate *after* the time of the census, apparently into late September (Kelly unpubl. data). The apparent absence of the six beach species in some locations during the annual census may therefore have been due to the antecedent mortality or delayed germination of plants at those sites. While such occurrences appeared from this study to be relatively rare, even a single missed individual can have implications for both conservation and regulatory purposes, especially if it is the only individual appearing at some location in a given year. Greater survey frequency within years is therefore ideal when possible, and with the help of trained field assistants and interns, attempts have been made to do so whenever possible in recent years in New Jersey (Kelly unpubl. data) and will continue in the future.

Status of Historical Populations

While rare plant populations were found at many historical locations in 2001-2011, and by Snyder (1996, unpubl. data) in 1980-2000, most prior records for these species predate 1940. It is therefore unclear whether, or to what extent, these populations were actually *extant* at these locations in the many decades prior to these observations, either above ground or dormant in seed banks, or if they instead had recolonized locations where they were previously extirpated. The failure of prior surveys to locate *A. pumilus* and/or other rare beach plant species populations at various historical or other locations in New Jersey (e.g., Snyder 1996, unpubl. data., Stalter et al. 1996, Stalter 1994, Sutton et al. 1990) may be taken to suggest the latter. However, given the number of survey years that were required to capture the majority of populations observed in 2001-2011, it is also possible that the apparent absences of these species in previous studies were due instead to insufficient frequency, timing, or duration of the surveys relative to the above ground presence of the species in those areas. In any case, the highly intermittent and localized nature of what few studies have been conducted (and documented) in the past 60 years, make such questions about the historical status of these species seem unanswerable, at least in large parts of the state.

Given the conditions and circumstances of the New Jersey shoreline during the time period in question, however, it does seem likely that populations of rare beach plant species were in fact extirpated in many areas. Many of the beaches and habitats where *A. pumilus* was found in 2001-2011 (including the areas where it was rediscovered in Monmouth Beach and Sea Bright in 2000), for example, did not themselves exist for decades prior, and in other cases were severely degraded, due to longstanding erosion of the coastline, intense coastal development, hard shoreline stabilization, and land use (Nordstrom et al. 1986). In such locations, the likelihood of previous extirpation is more or less certain. The successful return of rare beach species to these areas in recent years, therefore, was made possible by the antecedent reconstruction of these and other beaches throughout the state by beach nourishment, or pumping sand from offshore deposits onto the beach surface. More funding has been spent on beach nourishment (per mile) in New Jersey than any other state (Western Carolina University 2012, Valverde et al. 1999), and the recent 21-mile project from Sandy Hook to Barnegat Inlet was the largest project (in terms of volume) of its kind in the world (USACE 2001). For beach-dependent species such as *A. pumilus* and *P. glaucum,* the large number of historical and *de novo* populations found in 2001-2011 is likely reflective to some extent of the large amounts of potential habitat created by these projects. Similarly, the widespread reconstruction of dunes throughout the state, which began in the wake of the Ash Wednesday storm of 1962 (Nordstrom et al. 1986) and continues to the present day, likely created large amounts of new potential habitat for *O. humifusa* and other dune species, and its return to several areas such as Cape May appears to have been associated with beach nourishment and dune construction as well (Snyder pers. comm.). While these activities undoubtedly increased the total area of potential habitat for these rare beach plant species, such results were not intentional, as the purpose of these activities was primarily for shoreline protection and support of human uses of the coastline. Questions have been raised about the potential negative effects of beach nourishment activities on rare beach species as well, especially regarding concerns for burial of existing populations and seed banks. Further research is therefore needed to better understand the broader impacts of beach nourishment and dune construction on the dynamics of rare beach plant populations, present or historical, in New Jersey in general, or on the consequences of any particular construction project at a given site.

Conclusions

Prior to this study, comprehensive surveys of rare beach plant species in New Jersey were generally lacking. The ten years of field data and 200 years of historical records presented here provide the first detailed perspective on the overall status and distribution of these rare beach plant species in the state as a whole, and their changes over time. However, for such species occurring in habitats as dynamic as the shoreline environment, and capable of long-distance dispersal and long-term seed dormancy, the decade of intensive field research conducted in New Jersey to date provides but a brief glimpse of the long-term dynamics of these species' populations and their ability to respond to continued environmental change.

The fact that it was possible to execute such large-scale field studies in ten nearly consecutive years with minimal amounts of time and funding suggests that systematic and comprehensive studies of this kind can be both feasible and fruitful, and may be similarly applicable for other species that exhibit a similar preference for a narrow range of habitat conditions as these beach plant species, and/or for those habitats that are geographically restricted, contiguous, and/or easily identifiable or searchable. Given the degree to which our ability to protect and conserve these species is impaired by a lack of knowledge that only such comprehensive, long-term studies can provide, funding of basic biological surveys of this kind should be a greater priority for conservation in the future.

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Bartonia No. 66: 61–70, 2013

The Historical Collection Locality Referred to as Egg Harbour, New Jersey

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The New Jersey coastal region has been the focus of botanical exploration for centuries and a number of notable 18th and 19th century botanists are known to have made trips there. For example, in the mid-18th century John Bartram visited numerous locations including Amboy and Shrewbury (1742), Little Egg Harbor (1763), Great Egg Harbor (1741, 1745, 1763), Cape May (1741,1742), and other sites (Hoffman and Van Horne, 2004). In the early 19th century, Constantine Rafinesque, Frederick Pursh, and Thomas Nuttall also made trips to the outer coastal plain of New Jersey. Rafinesque published his original description of *Amaranthus pumilus* Raf. (seabeach amaranth) with the following locality note, "I found it on an island at Egg-harbour in New Jersey" (Rafinesque 1808).

In a paper lectotypifying a specimen of *A. pumilus*, the locality of "Egg-harbour" provided by Rafinesque, was discussed by Macklin et al. (2005). They concluded that Rafinesque's "Egg-harbour" most likely referred to the Beesley's Point area (see Figure 1) in Cape May County and cited Stone (1911:365) as the source of this distinction. While describing the distribution of *Gymnadeniopsis integra* (Nutt.) Rydberg, Stone stated "[Thomas] Nuttall's original specimens in the Philadelphia Academy herbarium are labeled "Egg Harbour," which in those days meant Beesley's Point, on Great Egg Harbour."[1] These two sites were also connected by Stone (1911:188) in his description of *Amphicarpon amphicarpon* [=*Amphicarpon amphicarpum* Nash, *Amphicarpum purshii* Kunth], where he notes, "This curious grass, originally discovered by Frederick Pursh 'near Egg Harbor' (probably = Beesley's Point)..." Pursh's full description of the locality for this species [as *Milium amphicarpon* Pursh] is, "In light sandy fields of New jersey near Egg-harbour"(Pursh 1813:62). Pursh also uses the locality of "In deep swamps...near Egg harbour" for *Iris prismatica* Pursh (Pursh 1813: 30).

A reason for associating Beesley's Point and Egg-harbour is not given by Stone (1911), but in an earlier article Stone (1908) does state,

> Beesley's Point has many associations...Here both [Alexander] Wilson and [John] Audubon made their first acquaintance with the water-fowl...and here, too, all the early botanists made their headquarters when a large part of the flora of the surrounding wilderness was unknown to

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[1] The surname for which the Point was named, is found with the spelling Beesley or Beasley depending on the document. Maurice Beesley, author of *Sketch of the Early History of Cape May County* (1857), and son of Thomas Beesley, Sr. (for whom the Point was likely named), spelled it Beesley. This spelling is used throughout the present article, except for when quoting from text in which the name was spelled differently.

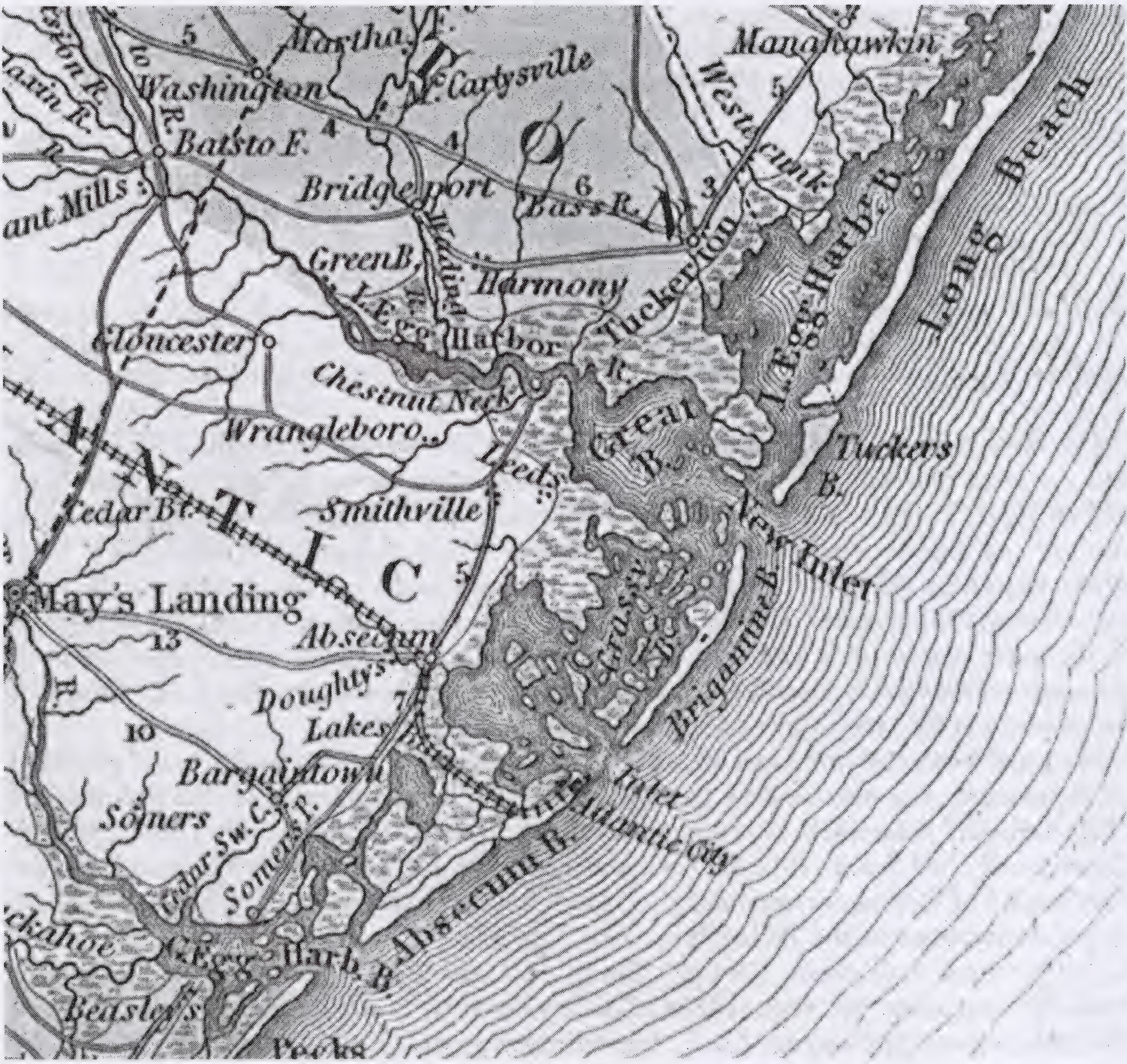

Figure 1. 1856 Map of New Jersey. Beesley's Point is in the lower left corner, bordering the southern side of Great Egg Harbor Bay. Tucker's Beach is found between Brigantine Beach and Long Beach Island. Little Egg Harbor Bay is west of Long Beach Island, while Great Bay is at the mouth of the Little Egg Harbor River [Mullica River] (Special Collections and University Archives, Rutgers University Libraries).

> botanical science. Thomas Nuttall especially was wont to scour this region for novelties, and his label "Egg Harbour" refers to the vicinity of Beesley's Point, on Great Egg Harbor Bay, not the later settlement of Egg Harbor City as some have inferred. In the herbarium of the Philadelphia Academy are two Nuttall specimens which bear this label, and it is not surprising that they were in my mind when I visited this historic spot [Beesley's Point], namely, *Gymnandeniopsis integra* and *Lilaeopsis lineata* [Greene; =*Lilaeopsis chinensis* (L.) Kuntze], but I saw nothing of either.

A letter from Alexander Wilson to Rubens Peale, referred to "…a specimen of the Grey Fox, Killed at Egg Harbour," and Audubon's and Wilson's journeys to Great Egg Harbor are very well documented (Wilson and Hunter 1983:376). Audubon gave a detailed account of his trip from Camden to Great Egg Harbor, and Wilson actually detailed his exploits with a "Mr. Beasley" (Audubon 1835:606-609; Ord 1828:clxi; Brewer 1854:337; Wilson 1813:

19). Based on Wilson's shortening "Great Egg Harbour" to just "Egg Harbour," it seems reasonable to assume that early botanical references to "Egg Harbour" mean "Great Egg Harbor" as well. But Stone's premise, that all the early botanists made their headquarters at this locale, is not as easily verified. Although Nuttall's travels to the western United States are well documented, descriptions of his explorations in New Jersey are lacking. Surprisingly, in her biography of Thomas Nuttall, Graustein (1967) does not mention Nuttall botanizing in New Jersey.

Stone (1908) recounted his and Samuel S. Van Pelt's rediscovery of *Lilaeopsis lineata* east of Palermo, NJ [south of Beesley's Point and Marmora].[2] Stone speculated (and hoped) that this was the same locality where Nuttall had found the plant nearly 100 years prior:

> Here it was within a short distance of Egg Harbor, as Nuttall used the term, and somewhere hereabouts he found it in 1817 or before, when it was known only from the types collected by Michaux in South Carolina, and perhaps from some other southern stations. Nuttall, taking it from the genus *Hydrocotyle* where Michaux placed it, called it *Crantzia*, and says 'abundant near Egg-harbour, New Jersey, in a salt-marsh with *Limnetis juncea* [*Spartina patens*], etc.' Who shall say that we had not rediscovered his identical station? It is an attractive thought, and we shall cling to it until it is shown that *Lilaeopsis* occurs at other points in the same vicinity.

Nuttall (1818) did make reference to Egg Harbour numerous times. He cited Rafinesque's original locality for *Amaranthus pumilus*, "Hab. On an island near Egg Harbour.-Mr. Rafinesque, New York. Med Repos. 2. P. 360. No. 22. *v.v.* (seen living). Probably upon the beach of the same island. Collected many years back by my friend Z. Collins, Esq...." A Nuttall specimen of *A. pumilus* in the herbarium of the Royal Botanic Gardens, Kew (barcode K000814908) has "Egg Harbour, N. Jersy" on the collection label and is written in Nuttall's hand. In his *Genera*, Nuttall also used the locality for *Artemisia caudata* Michx., "Hab. On the islands of Egg-Harbour, N. Jersey...," *Zostera marina* L., "Forming with *Ruppia* vast floating fields in the bay of Egg Harbour, New Jersey," *Polygonum glaucum* Nutt., "On the sandy beach of the sea, around Egg-Harbour...," *Crantzia lineata* Nutt. [*Lilaeopsis chinensis*], and *Salsola kali* L., "On the strand of Egg-Harbour..." (Nuttall 1818).

The connection between Egg Harbour and Beesley's Point was perpetuated by Pennell (1936) when he discussed Nuttall's plant collecting in New Jersey. Nuttall described a number of new species from the Pine Barrens and Coastal New Jersey, and regarding the latter, Pennell wrote, "Egg Harbor was the only locality mentioned on the coast of southern New Jersey...." In a footnote regarding the locality of Egg Harbour, Pennell cited Stone (1911) and stated, "Now Beesley's Point, on Great Egg Bay...." The 1894 book, *A Geographic Dictionary of New Jersey* also associated the name Egg Harbor with Great Egg Harbor, while separate entries were also given for Great Egg Harbor and Little Egg Harbor (Gannett 1894). Based on information provided by Stone (1908, 1911), it might be assumed that all of the early botanical collections at "Egg-harbour" were from the region of Beesley's Point.

In the following excerpt from his autobiography, *A life of travels and researches in North America and South Europe*, published in 1836, Rafinesque describes some of his early botanical explorations taken shortly after his arrival on the American continent in year

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[2] There was an earlier "rediscovery" of the species by K.K. Mackenzie, who in 1906, found the plant between Mantaloking and Chadwick on Barnegat Bay, but Stone was unaware of this at the time of writing his article (Stone 1911; Fogg 1934).

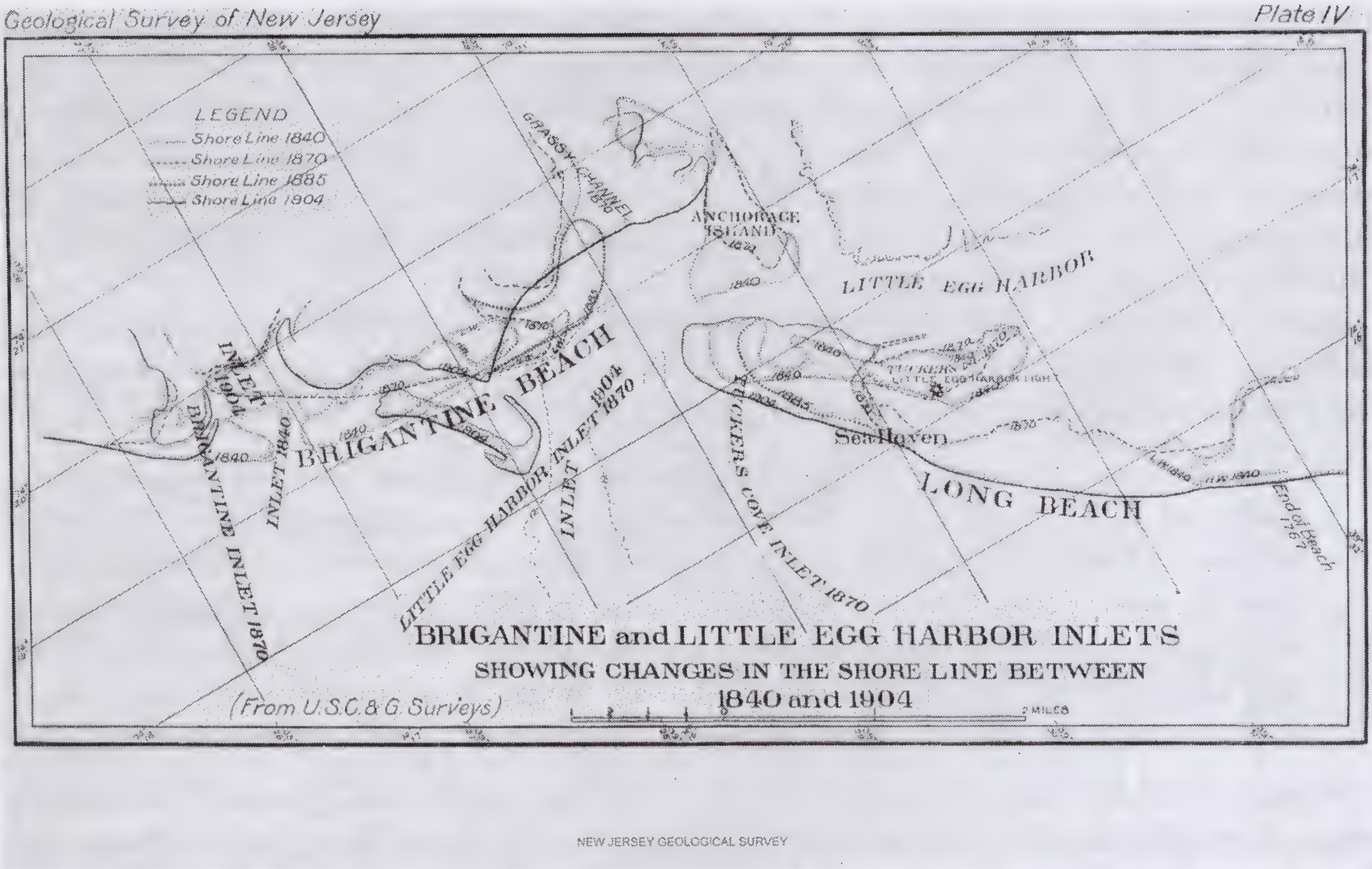

Figure 2. Little Egg Harbor Inlet and associated barrier islands, such as Tucker's Island, have changed dramatically over time. Reproduced from Kümmel (1906).

1802, "...undertook a journey through New Jersey to the Sea shore. We went in a cart through the Pine barrens to Tuckerton and Egg harbour. I made an ample collection of fine and new plants at Quaker bridge in the barrens, and at Tucker Island: I discovered many new plants in this Island, such as *Drosera filiformis* [Raf.], *Amaranthus pumilus* [Raf.], *Gerardia maritima* [Raf.; =*Agalinis maritima* (Raf.) Raf. var. *maritima*], &c." An interesting discrepancy arises from this statement: Rafinesque connects the locality of Egg Harbour to Tucker Island.

Tucker Island (Tucker's Island or Tucker's Beach) was purportedly home to one of the earliest seaside resorts and, at the time of Rafinesque's visit, was located near Little Egg Harbor Inlet, south of Long Beach Island (Figure 1; Di Ionno 1997; Veasey 2000; NPS 2005). This area is more than 20 miles north of Beesley's Point, near the dividing line between Ocean and Atlantic Counties. Tucker's Island is a fascinating example of the potentially transient nature of barrier islands. Some sources state that the island was previously known as Tucker's Beach because it was originally a part of Long Beach Island that was separated by the formation of a channel in the early 19th century (NPS 2005). Alternatively, Kümmel (1906) stated that Tucker's Island formed as a result of a channel cutting through the more southerly Mihannow shoal (seen in Figure 4), "and the northernmost island was known as Tucker's or Short Beach, while the southern was variously designated as Flat, Little, Island, or Brigantine, according to circumstances." Regardless of its origin, for a while Tucker's Island was home to multiple dwellings and eventually the Little Egg Harbor lighthouse and a lifesaving station. Over time, longshore currents and storm events severely eroded Tucker's Island. By the mid- 19th century Long Beach Island had extended south, eventually connecting with Tucker's Island in a hook formation (Figure 2; NPS 2005; NOAA 2008).

Beginning in 1917 severe erosion caused occupants to evacuate, and by 1938 the island had been completely washed away (NPS 2005; NOAA 2008). Because Rafinesque ascribed Tucker's Island as the original collection site of *Amaranthus pumilus*, some distance from Beesley's Point, the question must be raised as to the accuracy of Stone's connecting Egg Harbour to Beesley's Point, and whether historical references to Egg harbour may, as well, be referring to areas in the vicinity of Little Egg Harbor.

In his autobiography, Rafinesque recounts numerous trips to, or through, New Jersey (Rafinesque 1836). Only four of these trips were to the coastal region and all four were to the Tucker's Island area or points north. The first trip, in 1802, as previously quoted, was to Tuckerton, Egg harbour, and Tucker Island. His second excursion was in 1816 and passed through "New-hope and the hills of New Jersey... S. of the Raritan bay... landed also at Sandyhook" (Rafinesque 1836:50). The third trip occurred in 1827, where Longbranch and Shrewsbury inlet are described as stops on a trip to Boston (Rafinesque 1836:84). In 1833 he traveled again to the coast via "Burlington, Mount Holly, Vincentown, Budeltown...through the Grouseplains...stopped at Cedarbridge to botanize...," and he eventually described spending five days in Manahawkin and six days on Long Beach Island (Rafinesque 1836: 104-105). Based on his travel records, it seems that Rafinesque never visited the New Jersey coast south of Tucker's Island, and therefore it is likely that he never went to Great Egg Harbor Bay.

Although Rafinesque's writings have connected Egg Harbour and Tuckerton, the question remains as to whether the "Egg Harbour" of Nuttall and Pursh should still be associated with Beesley's Point in Great Egg Harbor or, like that of Rafinesque, with the Tuckerton area near Little Egg Harbor. Rafinesque stated that his 1802 trip to Tuckerton was via Quaker Bridge. Although Pursh and Nuttall did not document their botanical travels with the detail that Rafinesque did, it is possible that they visited the New Jersey Coast via the same route. This route, known as the Tuckerton Stage Road, connected Philadelphia and Camden to Tuckerton and Little Egg Harbor, and had a number of taverns and inns along the way (Beck 1936; Pierce 1957; Boyd 1991). One stop that was popular with early botanists (as well as current-day) was the pine barrens locale known as Quaker Bridge. Pursh was documented as being on a trip that stopped at Quaker Bridge in 1805 or 1808 (records vary on the correct year), and which resulted in the controversial discovery of *Schizaea pusilla* Pursh[3]. Interestingly, Pursh does mention traveling to Tuckerton in 1805. In his description of *Drosera filiformis*, Pursh gives the following notes, "In the pine-barrens of New Jersey near Tuckerton. This elegant species I discovered about 1805, in the place above mentioned [near Tuckerton]: this extensive swamp interspersed with sand hills, might be called a natural botanic garden..." (Pursh 1813, Vol 1:211). Nuttall (1841) also reported botanizing in the vicinity of Quaker Bridge, where he collected *Pityopsis falcata* (Pursh) Nutt.

Consulting historical documents, books, and maps of the New Jersey coast line from the 18th- 21st century reveals that the names of some geographic features have changed over the centuries, while others have remained the same. Early 18th century maps have labels for

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[3] The controversy surrounds who actually discovered the plant, as Pursh published the species with no mention of the others (C.W. Eddy, J. LeConte and C. Whitlow) that were present on trip (Pursh 1813:657; Chrysler and Edwards 1947:49, Ewan 1952; Fairbrother and Edwards 1992:152-153). Later, John Torrey and William Cooper stated that, "...and though he [Dr. Eddy] and Mr. LeConte found all the specimens, Pursh has claimed the honor of discovery himself (Redfield, 1869, 1876). Rafinesque (1818) wrote more forcefully, stating that Pursh was guilty of pilfering the discovery, as he did not find a single specimen, and as Eddy had plans to publish the species himself.

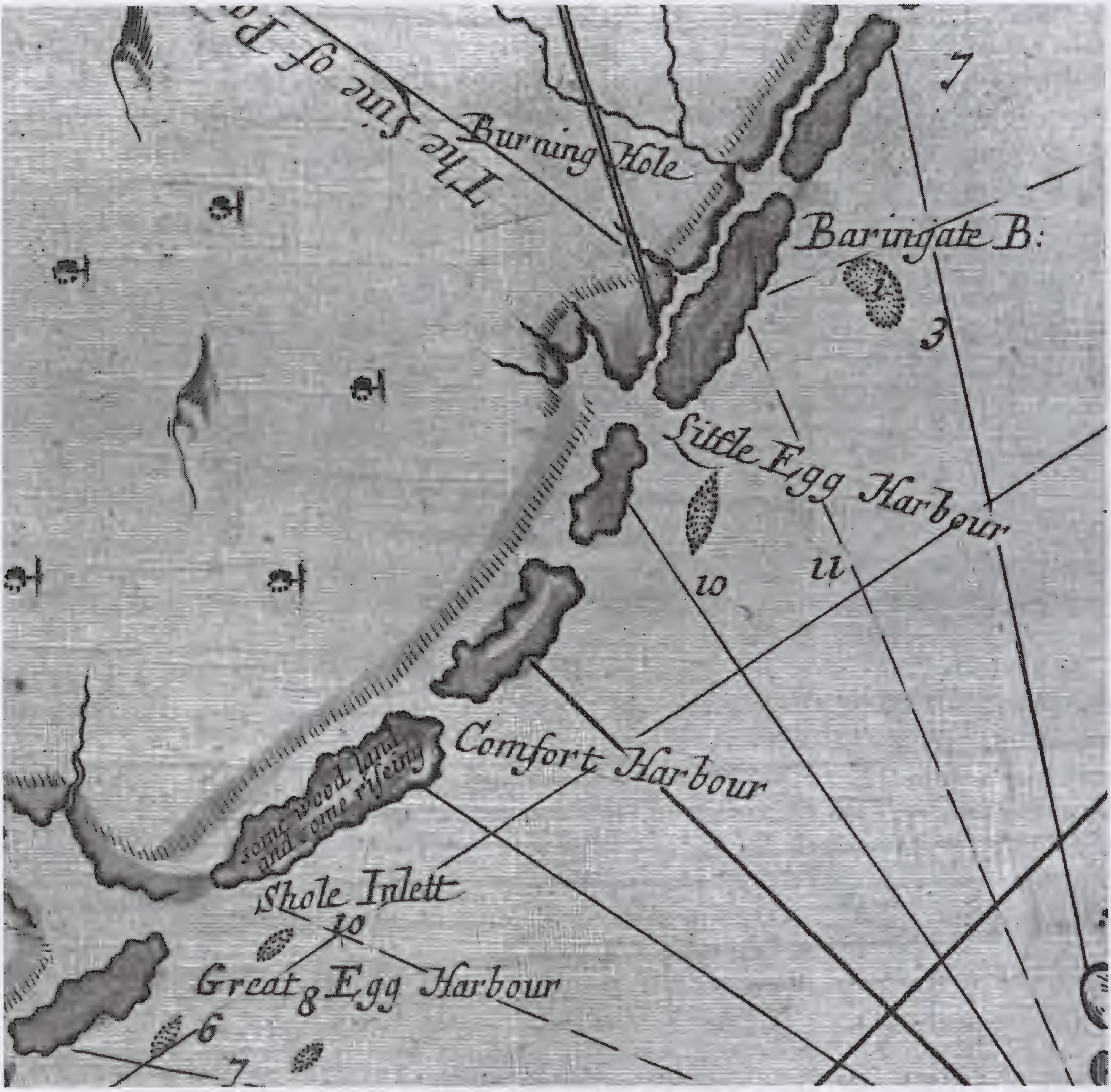

Figure 3. 1706 Map of New Jersey Showing only Great Egg Harbour and Little Egg Harbour (Library of Congress, Geography and Map Division, 2013a).

both Great Egg Harbour and Little Egg Harbour and Great Egg Harbour Inlet and Little Egg Harbour Inlet. Some of these early maps refer to the entire Little Egg Harbor area as Little Egg Harbour (Figure 3) while others call it Flat Bay (Figure 4). Near the mid- 19th century, Little Egg Harbor was being defined as the area east of Tuckerton and north of the peninsula now called Great Bay Boulevard Wildlife Management Area and the area south of that peninsula, at the mouth of the Mullica River, became known as Great Bay (Figure 1). A detailed discussion of the early changes in this coastal area can be found in Kümmel (1906). In *A gazetteer of the state of New Jersey*, Gordon (1834) gave descriptions of what constituted Great Egg Harbour and Little Egg Harbour:

> The Little Egg Harbour bay and inlet, and Great bay, form a sheet of salt water, separated from the ocean by Brigantine, Tucker's, and Long beaches…The collection district of Little

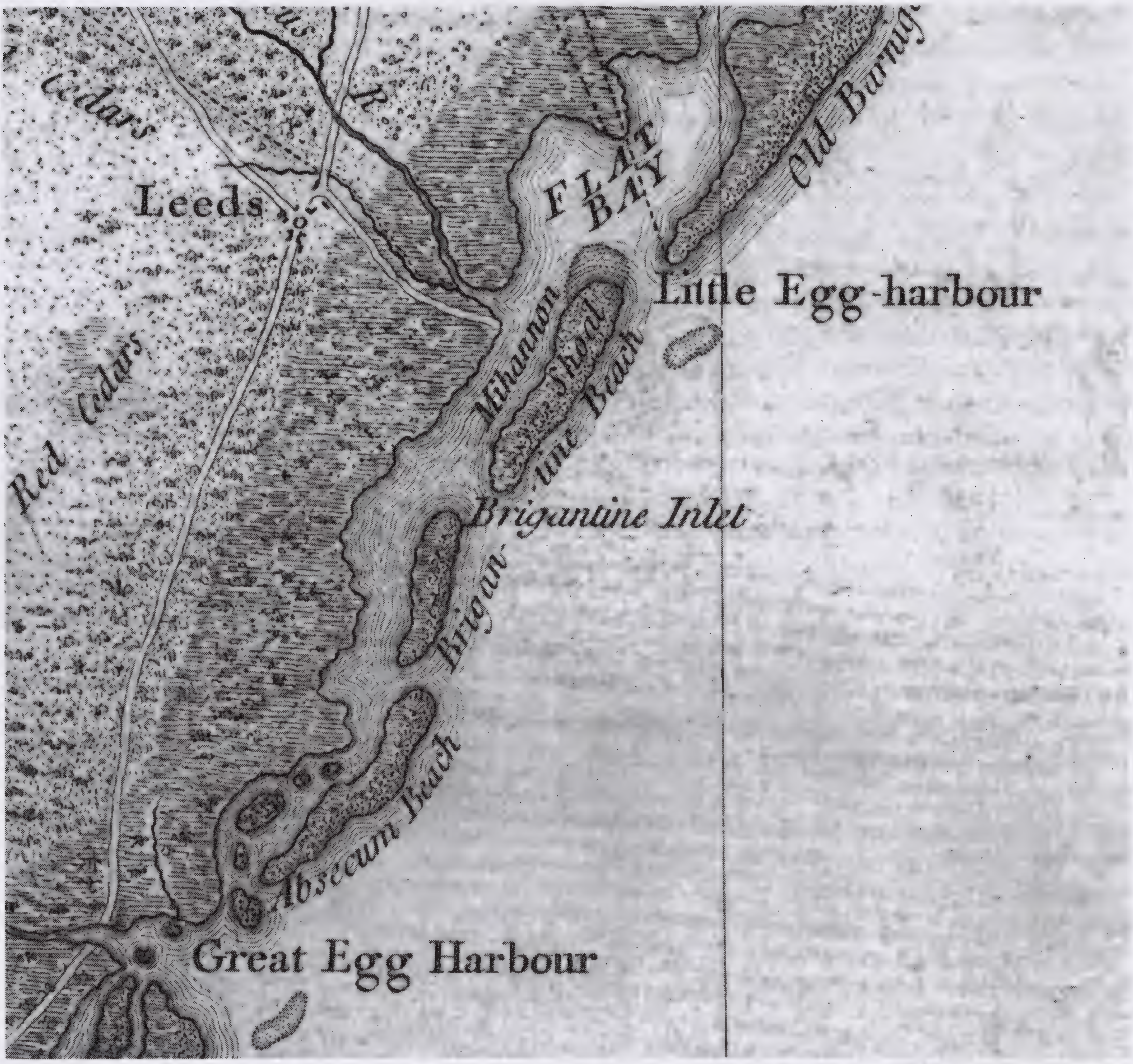

Figure 4. 1777 Map of New Jersey showing both Great Egg Harbour and Little Egg Harbour as well as Flat Bay (Library of Congress, Geography and Map Division, 2013b).

> Egg Harbour, comprehends the shores, waters, bays, rivers and creeks, from Barnegat inlet to Brigantine inlet, both inclusively...Great Egg Harbour, collection district, comprehends the river of Great Egg Harbour, together with all inlets, bays, sounds, rivers, and creeks, along the sea coast, from Brigantine inlet to Cape May.

The area known as Beesley's Point was first known as Goldin's (or Golden's) Point and in the latter 18th century as Willets Point, followed by Stites Point (NPS 1991). A plantation and tavern on the Point was bought by Thomas Beesley, Sr. in 1803, and by 1834 "Beasley's Point" or "Beesley's Town" was listed in gazetteers (Gordon, 1834; Wright 1834; Beesley 1857; NPS 1991). By the 1850s specific references to Beesley's Point can be found in correspondence and published articles (Baird, 1855; Ashmead 1857). In a paper on the Marine invertebrate fauna of the Coasts of Rhode Island and New Jersey, Joseph Leidy (1855) describes "...invertebrate animals collected by Samuel Ashmead Esq., or myself, in short visits to Absecom Beach, in the vicinity of Atlantic City, New Jersey, and to Beesley's Point, at the mouth of Great Egg Harbor, New Jersey.

Rafinesque most certainly spent time around Little Egg Harbor. Although the records of Pursh's and Nuttall's travels to the coastal areas of New Jersey are lacking by comparison, there is still some evidence that they botanized coastal New Jersey in the vicinity of Tuckerton and Little Egg Harbor, as well. As a result, doubt is cast on the sole association of Egg Harbour with Beesley's Point as put forth by Stone (1911). Historic herbarium specimens with the locality Egg Harbour, and references to this site in the early regional Floras, cannot be ascribed to Beesley's Point without additional evidence. Other factors such as habitat of the species in question, traveling records of the botanist, etc. must also be taken into consideration. Absence of evidence is not evidence of absence, and therefore it is certainly possible that these early botanists may have visited Great Egg Harbor, but to date, there are no known primary sources showing that they did.

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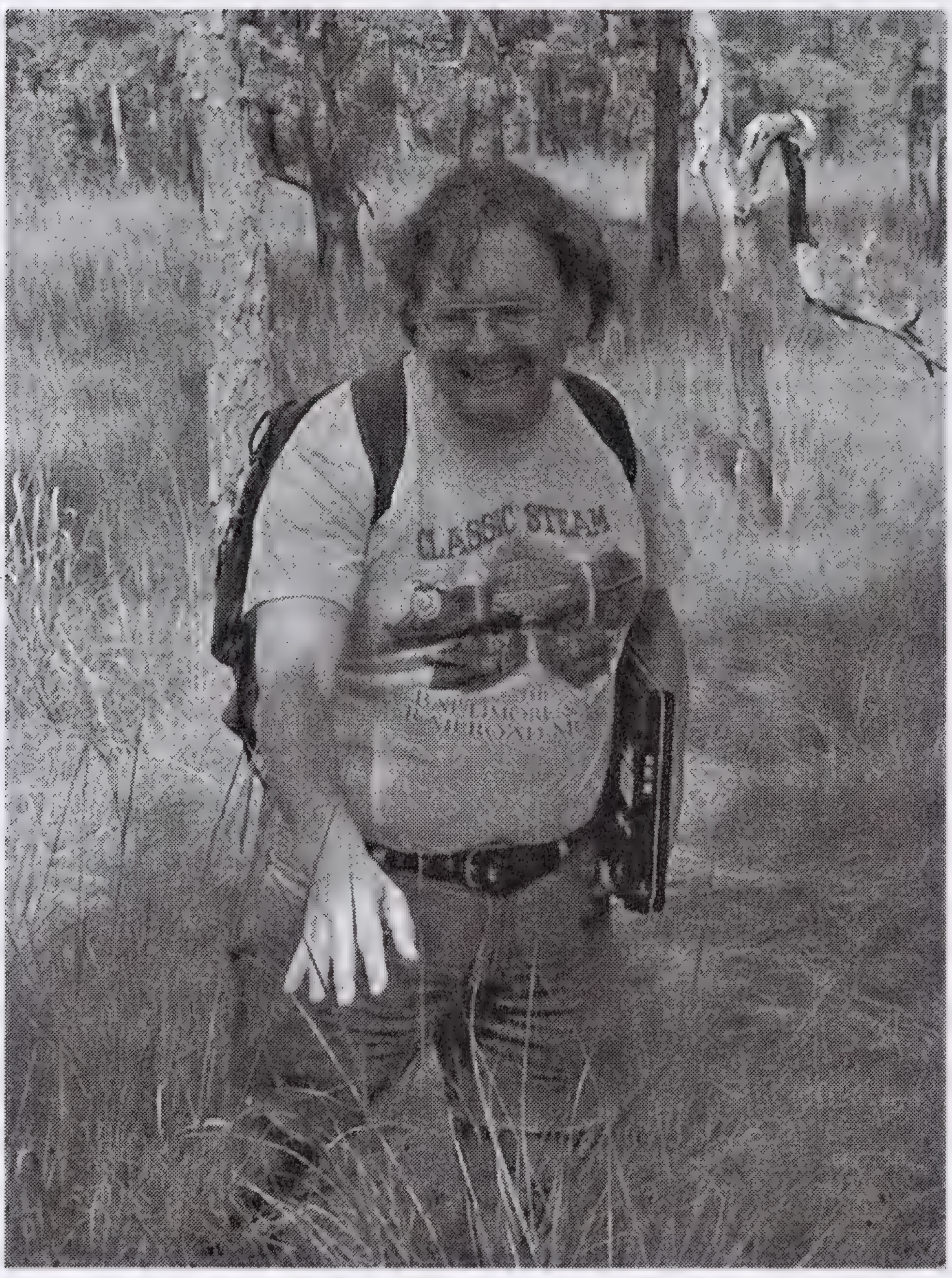
Bartonia No. 66: 71–73, 2013

Larry E. Morse (1947-2012)



Many in the field of botany knew Dr. Larry E. Morse as a brilliant, but sometimes eccentric, scientist. To me he was an older brother who turned a childhood interest into a career. It was not surprising to the family that he gravitated toward botany. It may have been the environment we were raised in, or a natural inclination to know, in detail, the natural world.

Larry was the eldest child of Carson and Dorothy Morse. He was born in Dayton, Ohio early in the Baby Boomer era. He was followed shortly by a sister, four years later a brother, and four years after that I came along. We were in many ways a typical suburban family. We were all in scouts. Larry was the Eagle Scout of the family and completed most of the badges offered at the time. He participated in summer scout camp and winter Klondike Derbies. The family took annual camping and canoe trips. We would visit National Parks and fish in the Georgian Bay Area of Ontario.

When your father is an engineer and your mother a research biologist and teacher, it is only natural to gravitate toward the sciences. This was what separated Larry from the other kids in the neighborhood. The house we grew up in had shelves of books on science topics including books on evolution, genetics and lots of field guides. There was a room in the basement called the "Lab." Larry had a work area in the Lab. From a very young age Larry collected things, including rocks and fossils, insect and leaves. He spent many hours each family vacation gathering tree and rock specimens. In the Lab were cabinets of mounted leaf specimens, shelves with Cornell boxes of insects and a very advanced chemistry set.

By the time Larry was in high school the collections had expanded to homemade herbaria cabinets in the attic. He also had a quest to find the biggest trees in Ohio. Two of his record setting trees are still listed on the Ohio Big Tree Program webpage.

Larry expanded his knowledge through a number of natural history programs and classes offered at the Dayton Museum. He completed the Junior Naturalist and Junior Curator education programs, took summer natural history classes, and competed in the summer Museum Fair science competition. In the summer of 1967 he worked on the oldest botanical collection from the Dayton area, which is housed at the museum, and taught classes in tree identification. He went from being the student to the instructor. His work on the botanical collection earned him the August F. Foerste Associate Award for outstanding young adult service to the museum.

Larry conducted many science experiments in the basement. Sometimes his experiments got him in trouble. He used his chemistry set to make fireworks and tested them in the basement. Most of his experiments helped build his understanding of the natural world. His research in high school on yellow raspberries took him to the state science fair and helped him become a Presidential Scholar and a finalist in the Westinghouse Science Talent Search in 1966. It also helped him attend the National Youth Science Camp held in West Virginia.

Larry attended Michigan State University where he continued to study botany. He started a project to use computers to help identify plants and completed an internship at the Smithsonian Institute. His graduate studies found him in Boston attending Harvard. He took a two year break between his Masters and PhD programs to work at the Smithsonian again. By this time Larry was settling into living on the east coast and only occasionally visited Ohio. After completing his PhD at Harvard he worked at the New York Botanical Garden. He later worked for The Nature Conservancy and Nature Serve as a botanist. Before Larry retired he was interviewed by All Things Considered on NPR. He took them in the field to look for a wild grape that had not been seen for decades in the DC area. The interviewer heard a bird calling and asked Larry if he could identify it. Larry's answer was "I don't do birds." His degrees may have been in biology, but he was 100% botanist.

DIANA MORSE

January 30, 2012 was a most grievous day for all who shared a passion for natural history and conservation in North America. Dr. Larry E. Morse, one of our most ardent supporters of conservation, and a friend to many, died suddenly at his Washington D.C. apartment. Larry Morse was born in Dayton, Ohio in 1947. From a young age, Larry became an ardent nature enthusiast and focused his interest on the woody plants of Ohio.

By all accounts, Larry was a child genius. At the young age of nine, Larry was already reading college-level physics books on subjects of electricity and magnetism, on the big bang theory; and reading classic biology books, such as Darwin's *On the Origin of Species*. Larry received his BS from Michigan State and his MS and PhD from Harvard University. While enrolled as a student at Harvard, Larry took time off to work at the Smithsonian Institution and NYBG on aspects of the Flora of North America program. As a student at Harvard, he took course work from internationally known scholars such as Dr. Ernst Mayr, spent time with intellectual giants such as Dr. Stephen J. Gould, served as a laboratory instructor under the direction of Dr. E.O. Wilson (who remained a friend of Larry's throughout his life), and completed his Ph.D. under the tutelage of Dr. Reed Rollins, an internationally recognized expert on the mustard family, Brassicaceae.

After graduating Harvard in 1979, Larry focused his attention on biological conservation, a subject that dominated the remainder of his professional career. In the 1980s Larry began working under the direction of Dr. Robert E. Jenkins of The Nature Conservancy. Together, along with colleagues, they perfected the most successful data-driven system ever attempted to establish broad-based conservation programs across the Americas. Known as Natural Heritage Programs, these usually state-level or province-level programs gained in popularity throughout the latter half of the Twentieth Century and influentially continue today.

Due in part to health issues, during Larry's latter years, he took partial retirement and focused on personal goals. Even though his health continued to fail, Larry never lost his desire to fight for issues in which he believed. Even in his last days, Larry shared with me ideas and thoughts that he wished to pursue — issues for conservation along with plans for making plant collection trips, etc. He and I were collaborating on an effort to develop a paradigm for establishing a new North American Biological Survey.

Larry was a great friend to all who shared an interest in plant conservation, to all who cared about protecting wild plants in wild places, and to all who have fought for fairness, applauded ethics, encouraged education and believed in so many other important things that we recognize in our society as being good.

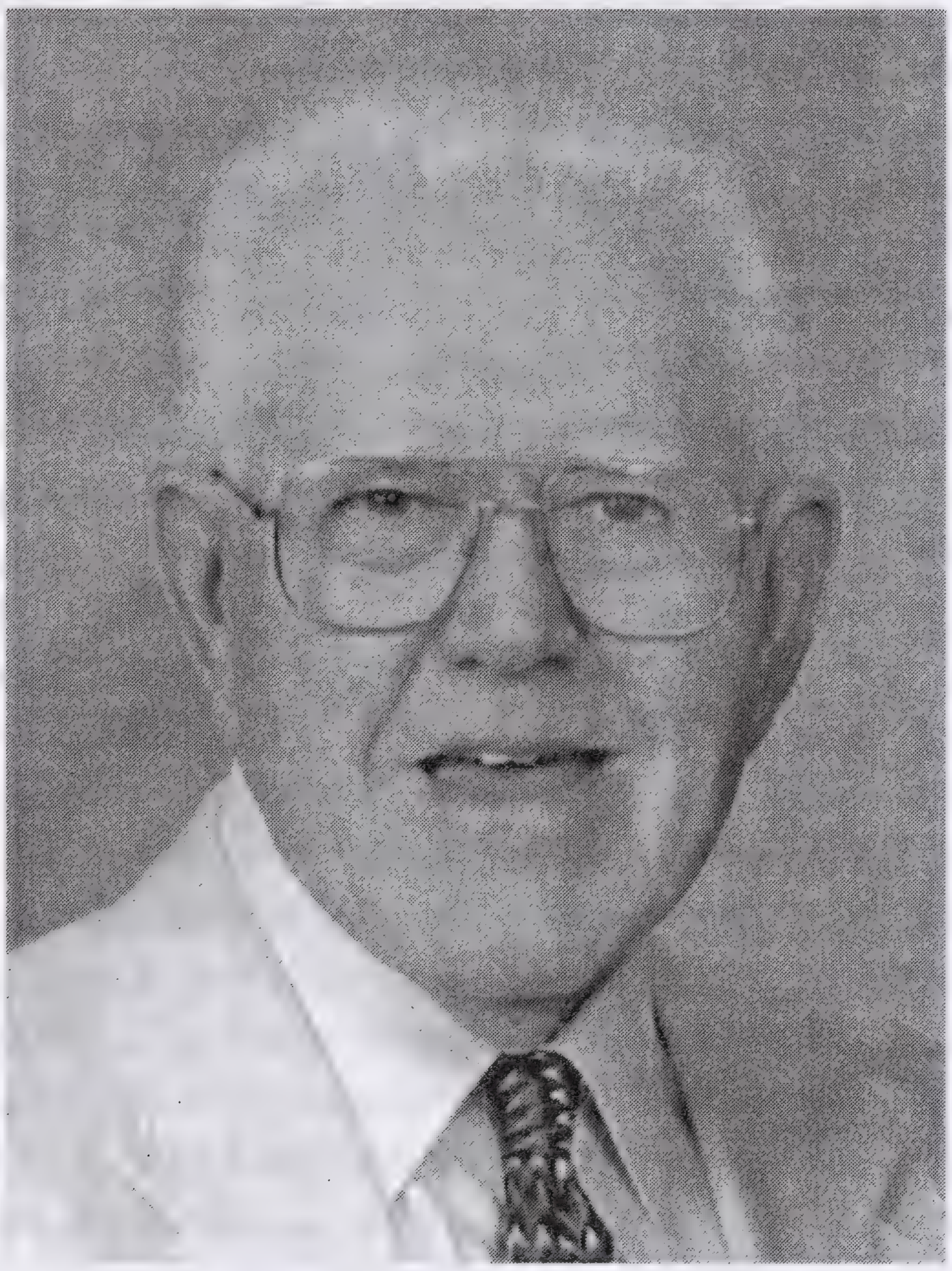
It's unlikely that we shall be fortunate enough again to have such an honorable and intelligent man, so committed to plant conservation and to the protection of rare species. Larry spoke often and eloquently of how future generations would need to carry the torch of plant conservation that he and others had carried so ably for decades.

Years ago, I read a quotation attributed variously, which in many ways reminds me of Larry's life-long commitment to conservation. "I have lived my life as a warrior, so that my son might be a farmer, so that his son might be a merchant, and so that his son might live his life as a poet." Hopefully, with the passing of each generation, perhaps, it might be possible to enlighten non-believers of the need to conserve and protect species and habitats, and to reduce the burden of politics that often cripple the minds of many who refuse to accept or understand the consequences when we fail. This was Larry's mantra in life – one that he seemed to march to daily. It is with profound sadness that we shall miss our great friend and superb proponent of conservation.

DR. JOHN KARTESZ, DIRECTOR
BONAP
CHAPEL HILL, NC

Bartonia No. 66: 74–77, 2013

David E. Fairbrothers[1]



Dr. David E. Fairbrothers (1925-2012) had a long, illustrious career in plant science, plant conservation, and education. In the era prior to DNA sequencing, he was a pioneer in chemotaxonomy, using serological methods to assess systematic relationships. He was also a tireless advocate for the preservation of rare and endangered flora in the United States, particularly in the state of New Jersey.

David Fairbrothers was born Sept. 24th 1925 and grew up in Absecon, New Jersey. He served in Europe during World War II as Sergeant Squad Leader in the 94th infantry. During the Battle of the Bulge he nearly lost his legs to frostbite, but refused amputation and eventually regained their use. Following the war, he received his bachelor's degree from Syracuse University in 1950. He attended graduate school at Cornell University earning his master's degree in 1952 with the thesis entitled "A cytotaxonomic investigation within the genus *Echinochloa.*" He continued at Cornell and in 1954 earned a Ph.D. with his dissertation "Relationships in the *Capillaria* group of *Panicum.*"

After a short stint as an Instructor in Botany at Cornell in 1954, he started at Rutgers University as an Instructor in the Department of Botany that same year. David stayed at Rutgers for 34 years, climbing the ranks, to the highest academic position attainable, Distinguished Professor II. He served in various administrative positions at the University, including Director of the Rutgers' Botany Graduate Program (1969-1972), Chair of the

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[1] A slightly different version of this remembrance, which also included an electronic supplement with Dr. Fairbrothers publication record, was first published in Taxon 62(2):420-421, and has been reproduced in this modified form with permission.

Department of Botany (1971-1978 and 1980-1981), and after departmental mergers, David served as Chair of the then newly formed Department of Biological Sciences (1981-1982). Following retirement in 1988, David held the title Professor Emeritus and was associated with Cook College (now called School of Environmental and Biological Sciences). Thirteen years after David's retirement, I (Lena) was hired as his replacement to teach and do research in plant systematics at Rutgers University, and during the intervening time the herbarium at Rutgers had moved to the Douglass Campus from Busch Campus.

During his career David was integral in the growth and activity of the Rutgers University's Chrysler Herbarium (CHRB), first serving as Curator (1954-1972) and eventually becoming Director (1972-1990). Over this time period the herbarium collections tripled from approximately 40,000 specimens to over 120,000 specimens through active collecting as well as acquisition of orphaned herbaria from institutions in the state (Rutgers-Camden, Rutgers-Newark, Douglass College, Willowwood Arboretum, etc.).

David recognized that the specimens at CHRB (and other herbaria in the region) served as an important resource for assessing the distribution of rare plants in New Jersey. In 1973 he and Mary Hough produced the first "red list" of rare and endangered vascular plants for a U.S. state. The New Jersey Red List preceded the 1973 Federal Endangered Species Act and inspired other states in the nation to assess species' rarity and compile similar documents. After the passing of the Endangered Species Act of 1973, which primarily provided protections for threatened and endangered (T&E) animal species, the Smithsonian Institute was directed to prepare a report on T&E plant species in the United States. David served as a member of the committee that prepared this report, and when completed, this document included definitions for rarity statuses and a list of over 3000 potentially T&E plant species. The report influenced the U.S. Fish and Wildlife service to review the status of the listed plants, and eventually led to the inclusion of more substantial plant-specific regulations in the Endangered Species Act.

David also had a tremendous impact on the conservation of the biodiversity and habitats of the New Jersey Pine Barrens, an internationally important ecological region located in southeastern New Jersey. The pinelands overlies the ~17 trillion gallon Kirkwood-Cohansey aquifer and has characteristic sandy soils and a variety of habitats including pine/oak upland forests, Atlantic white cedar and hardwood swamps, wet meadows and oligotrophic lakes, bogs, and streams. It encompasses approximately 1.1 million acres (22% of New Jersey's land area) and is home to many rare plant species including curlygrass fern (*Schizaea pusilla*), bog asphodel (*Narthecium americanum*), and American chaffseed (*Schwalbea americana*).

David possessed a great ability to translate botanical scientific information and terminology so that the general public and both private and governmental agencies could understand and then use such information in important decision-making processes. In that capacity, he presented expert testimony to the U. S. Senate Committee on Parks and Recreation and Natural Resources advocating for the development of the Pinelands National Reserve (PNR). The PNR was subsequently created by Congress, under the National Parks and Recreation Act of 1978 and was the first National Reserve in the nation. In 1983, the United Nations, through UNESCO's Man and the Biosphere program, identified the Pinelands Reserve as one of the world's outstanding natural areas and designated the area a U.S. Biosphere Reserve. In 1988 it was recognized as an International Biosphere Reserve.

Following the formation of the PNR, David continued to provide his expert assistance by preparing the report *Threatened and Endangered Vascular Plant Species of the New Jersey*

Pinelands and their Habitats for the newly formed Pinelands Commission. This report, and a book chapter, *Endangered, Threatened, and Rare Vascular Plants of the Pinelands and their Biogeography*, were the foundation for determining the initial species to be protected under the Pinelands Commission's Comprehensive Management Plan. He also presented to the Commissioner of the New Jersey Department of Environmental Protection the appropriateness and scientific background for the formation of a New Jersey Natural Heritage Program.

The Fairbrothers' laboratory group worked in many different areas of plant science including morphology, anatomy, ecology, floristics, genetics, and systematics. The lab conducted pioneering research using immunological methods (quantitative and double diffusion precipitin tests and immuno-electrophoresis) and electrophoretic techniques (PAGE, iso-electric focusing, 2-D) to compare plant proteins and elucidate evolutionary relationships. At that time, in the period prior to DNA sequencing, these were cutting edge methods in plant systematics. These techniques were initially used in the Fairbrothers lab to study groups in the Poaceae, and were subsequently used to assess higher-level relationships within Annoniflorae, Amentiferae and monocots, the orders Typhales and Cornales, as well as relationships in numerous families (Apiaceae, Betulaceae, Caprifoliaceae, Cornaceae, Magnoliaceae, Nyssaceae, Oleaceae, Rubiaceae), sub-families, genera (*Abies*, *Alnus*, *Amphipterigium*, *Betula*, *Carex*, *Coffea*, *Festuca*, *Leitneria*, *Osmunda*, *Typha* and *Viburnum*, etc.) or species therein. The lab also investigated cytogenetic, biochemical, morphological and anatomical variation, as well as the ecology of various species including *Opuntia humifusa*, *Danthonia sericea* and groups including oaks, oak relatives (*Nothofagus*) and *Mentha*.

David was a very prominent and influential figure in the international plant systematics community. As an undergraduate botany student in Sweden, I (Lena) had already read and cited David's papers on serology-based studies when I was investigating evolutionary relationships and classification history of the Gentianales for my undergraduate research thesis. A few years ago, I handed David my marked up copy of his paper from those years in the late 1980s, showing him how his research had became internationally known and was included in my early work.

In addition to research in systematics, David and his students conducted floristic works in New Jersey, producing inventories of William Hutcheson Memorial Forest, a tract of land in central New Jersey containing likely the oldest primary forest of this area, and assessing the floristic differences of sphagnum bogs in northern and southern New Jersey. He documented the introduction of non-native species such as *Nelumbo nucifera*, *Setaria faberii*, *Eragrostis curvula* and *Microstegium vimineum* to the US, and in 1965, Fairbrothers and Moul published *The Aquatic Vegetation of New Jersey*. In 1985, James Montgomery and David used herbarium records to document the distribution of ferns and fern-allies in New Jersey resulting in the publication of the book *New Jersey Ferns and Fern-Allies* in 1992.

David served on numerous scientific committees for the National Science Foundation (NSF), The New York Botanical Garden, and American Institute of Biological Sciences (AIBS), and served as advisor to the Pinelands Commission, member of the Board of Trustees for the Willowwood Arboretum Foundation, and as advisor for New Jersey Rare and Endangered Plant Species and Critical Habitats Program of the Natural Heritage Program. He also was on the editorial board of *Bartonia*, the journal of the Philadelphia Botanical Club (1975-1996), the review board of the *Australian Journal of Botany*, and served in many positions for the Torrey Botanical Club (president, vice president, member of council, representative to AIBS, etc.).

With a vibrant research program at Rutgers, he advised in total 29 Master's and doctoral students and six post-doctorates, and hosted numerous visiting scholars from around the world, helping to produce the next generation of plant researchers, many of whom became distinguished professors in their own right. David was a wonderful mentor to his students, fostering significant individual development as researchers and as honorable human beings. He provided not just scientific training, but also encouragement to attend botanical meetings and present papers, and participate in local botanical activities. The learning environment created by David, and the unconditional, personal support towards his graduate students, provided an outstanding place for young botanists to grow and develop. This is also true for us that met him late in his life, and he became an important mentor and friend to both of us in the last decade. David's wife, Marguerite Fairbrothers, was a tremendous companion for David through their life together and is still wonderfully supportive to us. She also serves as a role model especially for me (Lena) in her generosity with her time and attention, great sense of humor, as well as her deep honesty.

As a graduate student, I (Sasha) greatly appreciated David's encouragement and his remarkable stories about his life and research, botanical history, and the diverse New Jersey flora. When I first met David I was serving as the collections manager for the Chrysler Herbarium and he always expressed his great appreciation for my efforts in improving the herbarium and promoting its great scientific and historical value.

His extensive positive influence on the profession and the personal careers of his students and mentee's was noticed by many and led to several official recognitions. David received Rutgers' Lindback Award for Distinguished Teaching in 1981, the Rutgers' Presidential Award for Distinguished Public Service in 1983, the Rutgers University Medal (the University's highest award) in 1988, the Botanical Society of America medal (that society's highest award) and many other commendations and awards for service to botanical organizations in New Jersey and the nation.

After retirement, David continued to advocate for the preservation of New Jersey's flora. He was a founding member of the Flora of New Jersey Project, whose goal is to produce an updated atlas and a complete manual, for the Flora of New Jersey. David worked to develop the Emily De Camp Herbarium at Island Beach State Park, one of the last undeveloped coastal barrier islands in New Jersey. He continued to share his knowledge of plant science and conservation with many different community and governmental groups, giving lectures and leading numerous fieldtrips to the wonderful environments that he worked so hard to conserve.

With the passing of David Fairbrothers, the botanical community worldwide has lost a tireless advocate for plant biodiversity conservation and exploration. He was a fantastic mentor and champion for botanical education at all levels, from outreach toward the general public to graduate education, and he was a dear friend to many of us. We feel lucky that we got to know David while we have worked at Rutgers, and had the opportunity to be inspired by his strong dedication to science, ethics, and service to the world.

SASHA W. EISENMAN, TEMPLE UNIVERSITY
LENA STRUWE, RUTGERS UNIVERSITY

Bartonia No. 66: 78–81, 2013

BOOK REVIEWS

Old Growth Urban Forests (Springer Briefs in Ecology), by Robert Loeb. 2011. Springer Science+Business Media; New York. x + 69 pp. $49.95

Urban forests are rarely, if ever, thought of as "old growth." However, in Rob Loeb's new book, *Old Growth Urban Forests,* he concisely and clearly argues for the importance of considering old growth in an urban context, both for basic understanding of urban ecology and for determining how to manage trees in the urban landscape. With a thorough comparative case study of Fairmount Park and Central Park, this book is of particular interest to botanists in the mid-Atlantic region.

The book begins with a discussion of what old growth means for an urban forest. Contrasting traditional definitions of "old growth" with their exclusion of human influence on the forest, Loeb defines it as forests that date to "forest resetting events," such as forest clearance in the establishment of a human settlement, wars, hurricanes, etc. He explicitly allows for human influence on old growth urban forests. His discussion of urban forest typology further emphasizes this human influence as he covers street plantings and park landscapes in addition to unmanaged tracts. As the book proceeds, this inclusion of human influence allows for a fuller understanding of the ecology of these systems and a clearer vision of how to effectively manage them.

The second chapter of the book is a detailed case study comparison of Fairmount Park in Philadelphia and Central Park in New York City. It is filled with original research on the historical and current ecology of these sites, and has a rich bibliography on the past research and historical documents related to these parks. This chapter is an excellent resource for anyone interested in these sites or in urban ecology in general. The discussions of methodologies of historical ecology and paleopalynology are especially welcome, as they provide clear and concise summaries of how research in these disciplines is conducted, and provide excellent discussions of their strengths and potential weaknesses.

The book closes with a discussion of the management of old growth urban forests. It covers the technical difficulties of establishing management programs in systems whose ecologies are not well understood, and also the complexities of integrating the needs and interests of the wide variety of stakeholders involved in any urban forest's management. Adaptive management, where plans are implemented and continually reassessed and readjusted as they develop, is put forth as the most effective methodology for managing these forests. Given the complexities of the issues associated with them, and just how much remains unknown about how they work, Loeb makes a very persuasive argument for adaptive management as the most effective means of managing urban forests.

Robert Loeb's *Old Growth Urban Forests* is a tremendously effective introduction to the urban forest, with a particular appeal to foresters, botanists, and those interested in human ecology in the mid-Atlantic region. With its extensively documented case studies and descriptions of the methodologies of historical ecology and paleopalynology, it is appropriate for those new to the field and will be very useful to experienced researchers, as well.

David Hewitt
Research Associate, Academy of Natural Sciences

The Brother Gardeners: Botany, Empire and the Birth of an Obsession, by Andrea Wulf. 2008. Alfred A. Knopf, New York. xii + 358 pages. $35.00

A Great Book about Great People

Two of my favorite words are in the title of this book: Gardeners and Botany. It serves both extremely well in the context of 18th century England. Andrea Wulf gives a lively account of the accomplishments and interactions of her major characters: John Bartram, Peter Collinson, Philip Miller, Carl Linnaeus, Daniel Solander, and Joseph Banks. She has a knack for bringing history to life and enticing the reader to keep turning the pages for more.

Her description of the magnitude and results of the botanical connection between English cloth merchant Peter Collinson and American farmer John Bartram is enlightening. Not only did those in England receive American garden plants, they also imported American forests. At Lord Petre's Thorndon, tens of thousands of seeds from Bartram were ordered for one thousand acres of parkland. Other aristocrats followed suit. The formal arrangements of the baroque garden were rejected in favor of the "cultivated wilderness." American trees and shrubs were grown in an aesthetically pleasing manner to mimic nature. Gravel paths meandered through plantings intended to "appear accidental, as in a natural Wood." This new garden style caught on in Europe and led to the export of American forests by English nurserymen as well as English gardeners to care for them.

Wulf goes on to describe how Carl Linnaeus, the egocentric Swedish originator of the sexual system of plant classification and binomial nomenclature, gained a considerable respect for botany and horticulture in England. Philip Miller, head of the Chelsea Physic Garden, gets considerable credit for influencing Linnaeus because of the popularity *The Gardeners Dictionary*. Thus Linnaeus arranged for his student, Daniel Solander, to go to England to help him get plants and gardeners for his Uppsala garden. Among other tasks, Solander was to name plants in Collinson's garden according to Linnaeus's system.

Against the wishes of his Swedish mentor, Solander stayed in England and became a close friend of the wealthy "first Patron of Botany," Joseph Banks. This dynamic duo sailed around the world with Captain James Cook on the *Endeavor*. In Tahiti, we learn that Banks responded favorably to the velvety touch of the skin of Tahitian women. In Australia, Captain Cook named Botany Bay for the great quantity of new plants collected there by Banks and Solander.

Back in London, Banks turned his house on Soho Square into an "Academy of Natural History" with the herbarium at its heart. Championing the exploitation of useful plants as the way to a thriving empire, Banks convinced the king, "Farmer George," to expand the gardens at Kew and finance plant-collecting expeditions. Two of these expeditions were the voyages of Captain Bligh, who introduced breadfruit from Tahiti to the West Indies on his second voyage after surviving a mutiny in the South Pacific on his first voyage.

As gardening and botany became a national craze, Wulf tells us about Banks giving his wife a dried moss to wear as a brooch. Mrs. Banks rejected the moss—apparently she preferred diamonds. It would have been a perfect ending to Wulf's book if Mrs. Banks had worn a species of the moss genus *Bartramia*. History does not provide such perfection, but this book gives me renewed interest in the painting of Joseph Banks that hangs in the library reading room of The Academy of Natural Sciences.

ALFRED E. SCHUYLER
Curator Emeritus of Botany, Academy of Natural Sciences

Spring Wildflowers of the Northeast: A Natural History by Carol Gracie with a forward by Eric Lamont. 2012. Princeton University Press, Princeton and Oxford. xv + 272 pages. $29.95

Typical field guides have but scant information about any particular species contained within their pages. They can often leave a reader wanting a more detailed account of a plant's morphology and ecology. In *Spring Wildflowers of the Northeast: A Natural History*, Carol Gracie has pulled back the curtain to reveal the fascinating stories of more than thirty-five species of spring wildflowers found in the northeastern United States. Species accounts are organized alphabetically by common name and contain information synthesized from a wide array of sources. Each entry consists of a detailed yet succinct essay that generally includes discussion on habitat, range, morphology, taxonomy, phenology, pollination biology, fruit development, seed germination, animal interactions, and use in traditional medicine. For each plant, Gracie has provided a fascinating discussion and any reader will certainly learn many new things about even the most commonly encountered species. For example, many are familiar with the fascinating flower of skunk cabbage, which can often be found emerging through the snow covered ground in February, but who has delved underground to observe their remarkable roots, which grow and contract to better anchor the plant into its substrate?

Although the book only covers spring wildflowers, there is a wide array of species from numerous plant families. They range from commonly encountered non-native plants such as *Chelidonium majus* L. (greater celandine) and *Ranunculus ficaria* L. (lesser celandine), to more rarely seen native species such as *Hottonia inflata* Elliott (American featherfoil). Some families such as Berberidaceae, Ranunculaceae, and Orobanchaeae make repeat appearances with separate essays for multiple species, while Aristolochiaceae and Boraginaceae have only one species each. Essays vary in terms of the length and number of taxa covered. For example, there is one entry for Lady-slippers which covers both *Cypripedium acaule* Aiton and *Cypripedium parviflorum* Salisb., and the entry for violets mentions more than 20 taxa. My only quibble with this wonderful book is that the scientific names do not include the species authors.

In addition to fascinating information, there is an abundance of superb images (over 500!) that are used to illustrate various points such as morphological traits of the native species and their congeners found elsewhere in world. Some of my favorite images are the series of jack-in-the-pulpits with spathes cut-away to reveal the reproductive structures. These images nicely illustrate the fascinating discussion on how environmental conditions influence gender determination of these plants. Other noteworthy images are those capturing the interaction of ants with elaiosome-bearing Dutchman's breeches and bloodroot seeds. Fascinating animal-plant relationships are described for many of the species. Although insect pollinators and floral morphology receive the most discussion, and are quite interesting, some of the non-insect relationships, such as that of box turtles and may apples, and bears and skunk cabbage, are perhaps more surprising. Although the book primarily describes the biological or "natural" side of natural history, Gracie also touches upon the "history" side as well, with the most extensive discussion given for the violets. This group has been the subject of human interest throughout the ages from the Greeks and Romans to Shakespeare, and Napoleon and Josephine Bonaparte.

The book is very easy to read and Gracie presents complex subjects such as molecular systematics in a very understandable, conversational manner. Over all, it provides the reader with an intimate look at the fascinating and complex life histories of these plants and goes way beyond just appreciating a spring wild flower for its pretty face. I hope to see Gracie write additional books that will provide such great insight into other groups of plants found in this region.

SASHA W. EISENMAN
Temple University

Bartonia No. 66: 82–119, 2013

2009-2011 FIELD TRIPS

Reports reviewed, formatted, and edited by TED GORDON

2009 Field Trips

18 April (Saturday): Reception and Walk in Memory of Dr. William Overlease, South Campus, West Chester University, Chester County, Pennsylvania. Leaders: Jack Holt and Edith Overlease. No report received.

09 May (Saturday): Spring Wildflowers of Wallace Township, Chester County, Pennsylvania.

On a beautiful spring day, our small group joined the owners, Rick and Stacy Reinhart, to perform a plant inventory of their mostly wooded property on 60 Homestead Lane in Glenmoore. The central portion of Wallace Township is underlain by anorthosite, a rare igneous rock high in feldspar. The rich soil weathered from this rock, and the numerous springs and seeps that emerge from the rolling slopes south of the west branch of the Brandywine, nourish a diverse flora that has not yet been heavily impacted by either deer or alien invasives. The early portion of the walk was spent exploring the wooded edge and young thickety forest east of the property owners' home, where woodland natives competed with weedy species for space beneath thick underbrush of spicebush. Nodding trillium (*Trillium cernuum*) and Canada lily (*Lilium canadense*) were frequent species. Deeper into the woods, we encountered the first of many spring seeps on the property. Although dominated by skunk cabbage, many of these seeps also possessed open gravelly stretches, which were frequently covered with lush growth of mountain watercress (*Cardamine rotundifolia*), a common denizen of this habitat on anorthosite. Other interesting species growing in or along the banks of the seeps included single specimens of black ash (*Fraxinus nigra*), and butternut (*Juglans cinerea*), crested fern (*Dryopteris cristata*), swamp saxifrage (*Micranthes pensylvanica*), swamp buttercup (*Ranunculus caricetorum*), false hellebore (*Veratrum viride*), marsh violet (*Viola cucullata*), and a colony of a large wood fern tentatively identified as a hybrid (a return visit may be made to achieve proper identification). In between the rills and west of the seepage slope grew a lush variety of ferns, herbs, and shrubs under a varying canopy of tulip, oak, and beech. Richer, moister slopes under tulip and beech were home to species such as maidenhair fern (*Adiantum pedatum*), showy orchis (*Galearis spectabilis*), hepatica (*Hepatica nobilis* v. *obtusa*), bishop's-cap (*Mitella diphylla*), as well as more trillium and Canada lily. Dryer or more open areas, where blueberry, azalea, and maple-leaved viburnum replaced spicebush as the chief shrubs, hosted plants such as the clubmosses *Lycopodium hickeyi* and *L. obscurum*, Canada mayflower (*Maianthemum canadense*), rattlesnake plantain orchid (*Goodyera pubescens*), and yellow star-grass (*Hypoxis hirsuta*). After a break for lunch, several of the participants ventured into and across a powerline still recovering from clearing and spraying performed two years earlier. Here among other marsh and open-ground species the botanists encountered a population of *Carex vestita* in flower. The woods on the far side were equally as rich, rocky, and seepy as those on the east side, and yielded new additions to the plant list, including large-leaved aster (*Eurybia macrophylla*) and a small population of heart-leaved golden alexanders (*Zizia aptera*). We ended up along the banks of the west branch of the Brandywine, where we saw wild stonecrop (*Sedum ternatum*) and long-leaved chickweed, among other floodplain specialists. Over two hundred and fifty taxa were encountered during the trip, including two not seen in Wallace Township during a recent survey, *Carex vestita and Zizia aptera*. It is likely many species were missed, including numerous sedges too young to identify.

Plant List: *Acer platanoides*, *A. rubrum*, *A. saccharum*, *Achillea millefolium*, *Actaea racemosa*, *Adiantum pedatum*, *Agastache nepetoides*, *Agrimonia parviflora*, *A. pubescens*, *Alliaria petiolata*, *Allium vineale*, *Ambrosia artemisiifolia*, *A. trifida*, *Amelanchier arborea*, *Amphicarpa bracteata*, *Andropogon virginicus*, *Anemone americana*, *A. quinquefolia*, *Antennaria plantaginifolia*, *Anthoxanthum odoratum*, *Aralia nudicaulis*, *Arctium minus*, *Arisaema triphyllum*, *Arthraxon hispidus*, *Asarum canadense*, *Athyrium filix-femina*, *Barbarea vulgaris*, *Berberis thunbergii*, *Betula lenta*, *Boehmeria cylindrica*, *Botrypus virginianus* (*Botrychium virginianum*), *Cardamine bulbosa*, *C. concatenata*, *C. hirsuta*, *C. pensylvanica*, *C. rotundifolia*, *Carex amphibola*, *C. gracilescens*, *C. laxiculmis*, *C. pensylvanica*, *C. prasina*, *C. radiata*, *C. striatula*, *C. vestita*, *Carpinus caroliniana* var. *virginiana*, *Carya cordiformis*, *C. glabra*, *C. ovata*, *Celastrus orbiculatus*, *Celtis occidentalis*, *Cerastium fontanum*, *Chelone glabra*, *Chimaphila maculata*, *Chrysanthemum leucanthemum*, *Chrysosplenium americanum*, *Cinna arundinacea*, *Circaea lutetiana*, *Cirsium arvense*, *C. vulgare*, *Claytonia virginica*, *Clematis virginiana*, *Clinopodium vulgare*, *Collinsonia canadensis*, *Cornus alternifolia*, *C. amomum*, *C. florida*, *Coronilla varia*, *Corylus americana*, *Cryptotaenia canadensis*, *Dactylis glomerata*, *Danthonia spicata*, *Daucus carota*, *Dennstaedtia punctilobula*, *Deparia acrostichoides*, *Dichanthelium clandestinum*, *Dioscorea villosa*, *Dryopteris carthusiana*, *D. celsa x cristata* (?), *D. cristata*, *D. intermedia*, *D. marginalis*, *Duchesnea indica*, *Eleocharis tenuis*, *Epifagus virginiana*, *Epilobium coloratum*, *Equisetum arvense*, *Erigeron annuus*, *E. philadelphicus*, *Erythronium americanum*, *Euonymus alatus*, *Eupatorium fistulosum*, *E. perfoliatum*, *E. rugosum*, *Eurybia divaricata*, *E. macrophylla*, *Euthamia graminifolia*, *Fagus grandifolia*, *Fallopia scandens*, *Festuca obtusa*, *Floerkea proserpinacoides*, *Fragaria virginiana*, *Fraxinus americana*, *F. nigra*, *Galearis spectabilis*, *Galium aparine*, *G. circaezans*, *G. triflorum*, *G.* sp., *Geranium maculatum*, *Geum canadense*, *G. vernum*, *Goodyera pubescens*, *Hackelia virginiana*, *Hamamelis virginiana*, *Hesperis matronalis*, *Hieracium paniculatum*, *Holcus lanatus*, *Huperzia lucidula*, *Hypericum punctatum*, *Hypoxis hirsuta*, *Ilex verticillata*, *Impatiens capensis*, *Juglans cinerea*, *J. nigra*, *Juncus effusus*, *Lactuca biennis*, *L. canadensis*, *Lamium purpureum*, *Laportea canadensis*, *Leersia virginica*, *Ligustrum obtusifolium*, *Lilium canadense*, *Linaria vulgaris*, *Lindera benzoin*, *Liriodendron tulipifera*, *Lobelia inflata*, *L. siphilitica*, *Lonicera japonica*, *L. maackii*, *Lotus corniculatus*, *Ludwigia alternifolia*, *Luzula echinata*, *Lycopodium hickeyi*, *Lycopodium obscurum*, *Lycopus virginicus*, *Lysimachia ciliata*, *Lysimachia quadrifolia*, *Lythrum salicaria*, *Maianthemum canadense*, *Maianthemum racemosum*, *Medeola virginiana*, *Micranthes pensylvanica*, *Microstegium vimineum*, *Mimulus ringens*, *Mitchella repens*, *Mitella diphylla*, *Monotropa uniflora*, *Nyssa sylvatica*, *Oenothera biennis*, *Onoclea sensibilis*, *Osmunda cinnamomea*, *O. claytoniana*, *Oxalis dillenii*, *Packera aurea*, *Parthenocissus quinquefolia*, *Paulownia tomentosa*, *Penthorum sedoides*, *Persicaria arifolia*, *P. longiseta*, *P. sagittata*, *P. virginiana*, *Phegopteris hexagonoptera*, *Phragmites australis*, *Phryma leptostachya*, *Phytolacca americana*, *Plantago lanceolata*, *P. rugelii*, *Poa compressa*, *P. pratensis*, *P. trivialis*, *Podophyllum peltatum*, *Polygonatum*

biflorum, P. pubescens, Polystichum acrostichoides, Potentilla canadensis, P. norvegica, P. simplex, Prenanthes altissima, Prunus avium, P. serotina, Pycnanthemum virginianum, Quercus alba, Q. montana, Q. rubra, Ranunculus abortivus, R. caricetorum, R. recurvatus, Rhododendron periclymenioides, Rosa multiflora, Rubus allegheniensis, R. flagellaris, R. occidentalis, R. phoenicolasius, Rudbeckia laciniata, Rumex acetosella, R. crispus, R. obtusifolius, Salix nigra, Sambucus nigra subsp. *canadensis, Sanguinaria canadensis, Sanicula odorata, Sassafras albidum, Schizachyrium scoparium, Scirpus cyperinus, Scrophularia marilandica, Sedum ternatum, Smilax herbacea, S. pulverulenta, S. rotundifolia, Solidago caesia, S. canadensis, S. rugosa, Stellaria longifolia, S. media, Symphyotrichum cordifolium, S. lanceolatum, S. novae-angliae, Symplocarpus foetidus, Taraxacum officinale, Thalictrum pubescens, T. thalictroides, Thelypteris noveboracensis, T. palustris, Thlaspi arvense, Tilia americana, Toxicodendron radicans, Trifolium pratense, Trillium cernuum* v. *cernuum, Typha latifolia, Ulmus rubra, Uvularia perfoliata, U. sessilifolia, Vaccinium corymbosum, V. pallidum, V. stamineum, Veratrum viride, Verbena hastata, V. urticifolia, Vernonia noveboracensis, Veronica arvensis, V. persica, V. serpyllifolia, Viburnum acerifolium, V. dentatum, V. prunifolium, Viola blanda, V. cucullata, V. eriocarpa , V. hirsutula, V. labradorica, V. palmata* var. *stoneana, V. sororia, Vitis vulpina, Zizia aptera.*
Attendance: 8. Report by leaders: Jack Holt and Janet Ebert.

21-25 June (Sunday-Thursday): The Poconos at Dingmans Ferry, Pennsylvania. Annual Joint Field Meeting of the Torrey Botanical Society, the Philadelphia Botanical Club, and the Botanical Society of America, Northeastern Section.

The meeting took place at the Pocono Environmental Education Center (PEEC) in Dingmans Ferry. The field trips visited sites in the northern and central portions of the Delaware Water Gap National Recreation Area in northeastern Pennsylvania and northwestern New Jersey. The first day explored two scenic rocky ravines in Pennsylvania, Dingman's Falls and Hornbeck's Creek. The second day, also in Pennsylvania, examined marshy wetlands, upland forests on limestone, a floodplain forest, and a sandy outwash plain in the vicinity of Hogback Ridge, north of the Park Headquarters. The third day was spent in New Jersey, between Flatbrookville and Walpack Center, to observe a meadow, a pond, a dry road bank, a wet swale, and a floodplain forest. In addition, Bill Olson led two short early evening walks and the participants had opportunity to botanize the varied hiking trails on the grounds of PEEC.

Botanical highlights included a side by side occurrence of *Actaea pachypoda* and *A. rubra*, dense stands of *Asplenium rhizophyllum* on limestone outcrops, populations of *Panax quinquefolius* at two separate sites, an extensive population of *Hydrophyllum canadense* on a rich slope, large populations of *Lobelia spicata* and *Ranunculus aquatilis* in peak bloom, monumental specimens of *Angelica atropurpurea*, a wealth of carices including *Carex davisii* and *C. sprengelii*, and an easily overlooked population of *Goodyera tesselata* under hemlocks.

The evening programs included an illustrated lecture on the history of PEEC by **Jack Padalino,** former director of PEEC, plus brief informal presentations by some of the participants.
Attendance: 34, representing seven northeastern states. **Conference Chair: Bill Olson, who also served as field trip leader, along with Ted Gordon and Larry Klotz. Report by the latter.**

22 June (Monday): Haycock Mountain, Bucks County, Pennsylvania.

We climbed partway up the east side of Haycock Mountain on a trail that took us through rocky woods and past boulder fields. *Actaea racemosa* (*Cimicifuga racemosa*; black cohosh) was abundant. In the rockier areas, we saw *Sambucus racemosa* (red elderberry), a very large cluster of *Botrychium virginianum* (rattlesnake fern), and a single plant of *Adlumia fungosa* (Allegheny vine). In general the woods had few invasive plants, perhaps because the deer population is kept in check by hunting (Haycock Mountain is within one of the state game lands). Other plants included *Amphicarpaea bracteata*, *Asarum canadensis*, *Asclepias quadrifolia*, *Castanea dentata*, *Collinsonia canadensis*, *Conopholis americana*, *Cornus alternifolia*, *Desmodium nudiflorum*, *Galearis spectabilis*, *Galium triflorum*, *Geranium maculatum*, *Hepatica nobilis* var. *americana*, *Mitchella repens*, *Phegopteris hexagonoptera*, *Podophyllum peltatum*, *Rhododendron periclymenoides* (?), *Rubus odoratus*, *Sanguinaria canadensis*, *Scutellaria elliptica*, *Thalictrum thalictroides*, *Uvularia perfoliata*, *U. sessilifolia*, *Viburnum prunifolium*, *Viola palmata*, *V. pubescens*, and a past-bloom orchid that we tentatively identified as *Liparis liliifolia*.

A second stop was State Game Lands 56. The main attraction was a small moist meadow east of Lake Warren. This meadow appears to be kept open by mowing. We noted numerous plants of *Liatris spicata* (blazing-star), *Krigia biflora* (two-flowered Cynthia), and *Pedicularis canadensis* (wood betony). In wet ditches we noted two small annuals, *Juncus bufonius* (toad rush) and *Gratiola neglecta* (clammy hedge-hyssop). On somewhat higher ground we found an abundance of *Asclepias quadrifolia* (fourleaf milkweed) and *Aristolochia serpentaria* (Virginia snakeroot). Other plants included *Asclepias purpurascens*, *Cynoglossum virginianum*, *Hypericum perforatum*, *Hypoxis hirsuta*, *Lysimachia ciliata*, *Oenothera perennis*, *O. fruticosa*, *Penstemon digitalis*, *Polygala verticillata*, *Rosa caroliniana*, *Sisyrinchium angustifolium*, and *Triodanis perfoliatus*.

Finally, we made a quick stop at Nockamixon Cliffs, which is a high wall of hornfels (a metamorphic rock) rising above the Delaware River. The north-facing orientation of the cliffs ensures that the site stays cool, and the cliffs have long been known as a site of northern plants, notably *Rhodiola rosea* (*Sedum rosea*; roseroot). We think we were able to spot this plant high on the cliffs, but, because we had neglected to bring a spotting scope, we could not be certain. Other highlights were *Adiantum pedatum*, *Aquilegia canadensis*, *Arabis lyrata*, *Asarum canadensis*, *Heuchera americana*, *Hydrangea arborescens*, *Penstemon hirsutus*, and *Saxifraga virginiensis*.

Attendance: 6. **Report by leader: Janet Novak.**

28 June (Sunday): "Britton's Savannah" and vicinity, Middle Branch of the Forked River, Lacey Township, Ocean County, New Jersey.

An investigation of the botanical literature and herbaria records at the Academy of Natural Sciences (Philadelphia) and Chrysler (Rutgers University) suggests that little botanical exploration of the interior of the greater Forked River Mountains region had been conducted prior to the extensive surveys between 1983 and 2008 by T. Gordon, the trip leader. His most recent significant study (January 2009), titled Survey of Bog Asphodel (*Narthecium americanum*), Knieskern's Beaked-Rush (*Rhynchospora knieskernii*) and other Rare Species in the Middle Branch and South Branch Watersheds of the Forked River, Lacey Township, Ocean County, New Jersey documented multiple records of 23 element occurrences for the U.S. Fish and Wildlife Service and the Forked River Mountain Coalition.

From Wells Mills County Park on Route 532 west of Waretown, we drove northeast 2.6 miles on Switch Road, a pothole-riddled, sugar-sand trail, to a ca. 4,000 acre parcel of woodland, shrub thickets, and fens owned by the New Jersey Conservation Foundation. We next turned left and headed a ¼ mile northwest on the old Tuckerton Railroad right-of-way (R.O.W.) to its intersection with the headwaters of the central stem of the Middle Branch of the Forked River, where botanizing commenced. It was in this wetland corridor that Bayard Long, curator of the herbarium at the Academy of Natural Sciences, collected on July 10, 1915, both *Helonias bullata* (swamp pink) and *Scirpus longii* (Long's woolgrass). As on previous visits, we once again searched unsuccessfully for these globally rare taxa. Today, not much suitable swamp pink habitat remains here. It is likely that the 1915 occurrence was expunged as a result of severe prolonged flooding caused by clogging of the culverts beneath the R.O.W. after the 1936 abandonment of the Tuckerton line.

Long's woolgrass, however, a sedge that produces fruiting culms infrequently, is probably still lurking among culms of a significant population of *Scirpus cyperinus* (common woolgrass). Additional searching may someday be productive. An abundance of flowering *Nymphaea odorata* subsp. *odorata* (white water-lily) adorned the surface of the impoundment, and the arching stems of *Decodon verticillatus* (swamp loosestrife) had a strong presence. Along the dry-to-moist, trackless R.O.W., now an access road to service electric transmission lines, we saw in flower *Xerophyllum asphodeloides* (turkeybeard), *Tephrosia virginiana* (goat's-rue), and *Asclepias amplexicaulis* (blunt-leaved milkweed). Untimely mowing and assaults by off-road vehicles long ago destroyed the few scattered *Gentiana autumnalis* (pine barren gentian) that once prevailed in this segment.

We turned right at the stream, crossed it, and then headed northeast (downstream)1 mile on a loop trail that enscribed a relatively open, upland *Pinus rigida* (pitch pine)-*Quercus marilandica* (black jack oak)-*Quercus stellata* (post oak) forest on a gentle knoll ranging from 25-50 feet in elevation. Common shrubs in this fire prone community were *Gaylussacia baccata* (black huckleberry), *G. frondosa* (dangleberry), and *Eubotrys* (*Leucothoe*) *racemosa* (fetterbush), each in immature fruit. Less abundant were *Gaultheria procumbens* (teaberry), *Hudsonia ericoides* (pine barren heather), *Vaccinium pallidum* (lowbush blueberry), *Quercus ilicifolia* (bear oak), *Morella* (*Myrica*) *pensylvanica* (bayberry), *Pteridium aquilinum* var. *latiusculum* (eastern bracken), *Smilax rotundifolia* (common greenbrier), and flowering *Smilax glauca* (glaucous greenbrier). Also present were a few herbs: *Ionactis linariifolius* (stiff-leaved aster), *Tephrosia virginiana*, and *Melampyrum lineare* var. *pectinatum* (cow-wheat), the latter two in flower. *Danthonia sericea* (downy oatgrass), *Panicum virgatum* var. *virgatum* (switchgrass), and *Schizachyrium scoparium* var. *scoparium* (little bluestem) were also observed.

At "Britton's Savannah," situated along the major southern stem of the vastly dendritic Middle Branch system, it was not easy to get onto the open, sphagnous mat. It was necessary to bushwhack through the surrounding, dense 250± foot-wide thicket of shrubs including the 5 heaths, 2 greenbriers, and a bayberry already recorded, along with the following 5 additions in flower: *Gaylussacia dumosa* (dwarf huckleberry), *Kalmia angustifolia* (sheep laurel), *Rhododendron viscosum* (swamp azalea), *Ilex glabra* (inkberry), *Vaccinium macrocarpon* (American cranberry), and the herb *Xerophyllum asphodeloides*. Also present were *Rubus hispidus* (swamp dewberry), *Chamaedaphne calyculata* (leatherleaf), saplings of *Nyssa sylvatica* (sour gum), seedlings and saplings of *Acer rubrum* var. *trilobum* (trident red maple), flowering *Magnolia virginiana* (swamp magnolia), and *Chamaecyparis thyoides* (Atlantic white cedar) in various age classes. Comprised of numerous quaking bog carpets and sloughs, the 0.6-mile-long mat could perhaps be better designated a "poor fen" than a "savannah." We observed here on *Carex exilis* (coastal sedge) hummocks an impressive, flowering population of thousands of yellow stalks as well as numerous sterile vegetative patches of *Narthecium americanum* (bog asphodel), a globally rare (G2), state endemic and endangered member of the *Liliaceae*. Discovered by the leader in 1995, this de novo occurrence rivals any of the large populations of this lily in Wharton State Forest. Associated rare species observed in the western end were a few stems of *Juncus caesariensis* (New Jersey rush), a globally rare (G2) and state endangered rush, a small patch of *Sphagnum portoricense* (S2), and a few sterile tufts of the Pinelands listed (LP) *Calamovilfa brevipilis* (pine barren reedgrass). Sterile fronds of *Schizaea pusilla* (curly grass fern; G3), with fertile stalks just beginning to form on a few individuals, were widely scattered. Other rarities known to occur at his site in small numbers that were not seen during our survey were *Uvularia puberula* var. *nitida* (pine barren bellwort), *Carex barrattii* (Barratt's sedge), *Arethusa bulbosa* (dragon mouth), and *Eupatorium resinosum* (pine barren boneset). These occurrences could easily have been overlooked since the first three were already past their blooming period and the latter starts blooming in July. Contributing to the spectacular floral display were *Calapogon tuberosus* var. *tuberosus* (grass pink), *Pogonia ophioglossoides* (rose Pogonia), *Eriocaulon compressum* (early pipewort), *Lophiola aurea* (golden crest), *Nymphaea odorata* subsp. *odorata*, *Polygola brevifolia* (short-leaved milkwort), *Uticularia cornuta* (horned bladderwort), *U. striata* (fibrous bladderwort), *U. subulata* (zig-zag bladderwort), and the delicate flaring "bells" of *Gaylussacia dumosa*. Among the plants not in flower were *Bartonia virginica* (upright bartonia), *Drosera filiformis* (thread-leaved sundew), *D. intermedia* (spatulate-leaved sundew), *Drosera rotundifolia* var. *rotundifolia* (round-leaved sundew), *Oclemena nemoralis* (bog aster), *Orontium aquaticum* (golden club), *Platanthera blephariglottis* var. *conspicua* (white fringed orchid), *P. clavellata* (green woodland orchid), *Sabatia difformis* (lance-leaved sabatia), *Sarracenia purpurea* (northern pitcher plant; several goblets nearly 1 foot tall), *Pseudolycopodiella caroliniana* (Carolina bog clubmoss; frequent; spore-bearing stalks just beginning to form), *Woodwardia virginica* (Virginia chain fern), *Xyris difformis* var. *difformis* (bog yellow-eyed grass), *Carex striata* var. *brevis* (Walter's sedge), *Cladium mariscoides* (twig rush), immature *Rhynchospora alba* (white beaksedge), *R. fusca* (brown beaksedge), *Andropogon glomeratus* var. *glomeratus* (bushy beard-grass), *Eleocharis tuberculosa* (tubercled spikesedge), *Danthonia epilis* (bog oat-grass), *Dichanthelium dichotomum* var. *ensifolium* (Britton's panicgrass), and *Muhlenbergia uniflora* (late-flowering dropseed).

Some of the easternmost patches of bog asphodel of Britton's Savannah have been negatively impacted in the aftermath of a severe May 3, 1992 wildfire that has led to a gradual invasion by shrubs, especially *Ilex glabra*. This shrub canopy has prevented some of the bog asphodel clusters from flowering. A few of the westernmost patches of this lily have been similarly impacted by the encroachment of cedar saplings. The removal of these shade-producing invasives may enhance the survival chances of this rare population.

Thanks go to Bill Standaert and Janet Novak for assistance with the species list.
Attendance: 18. **Report by Leader: Ted Gordon**

11 July (Saturday): Carnivorous Plants of the Pine Barrens of New Jersey. Joint trip with the Pinelands Preservation Alliance (PPA).

Carnivorous plants held a special interest for Charles Darwin, whose 200th birthday we are celebrating this year. During the day at various wetland communities in the pine barrens, we examined carnivorous plants and their prey in the wild and in an artificial bog in Bill Smith's garden in Warren Grove, Ocean County. We also fed some of them. It was fascinating to see what *Drosera filiformis* did to hamburger.

In the evening at the headquarters of the PPA in Vincentown, we microscopically examined prey in pitcher plants (*Sarracenia*) and bladderworts (*Utricularia*). Rob Naczi gave a talk on pitcher plants and Gerry Moore talked about Mary Treat (1830-1923). Mary, who lived in Vineland, New Jersey, and corresponded with Charles Darwin, was the first to describe the trapping mechanism of the bladders of *Utricularia*. Refreshments were served by our host.

Leaders: **Ernie Schuyler, Rob Naczi, and Gerry Moore. Report by E. Schuyler.**

26 July (Sunday): Fulshaw Craeg Preserve, Montgomery County, Pennsylvania. Joint trip with the Muhlenberg Botanical Club.

Fulshaw Craeg Preserve, a Natural Lands Trust property near Harleysville, sits atop a band of diabase, a volcanic rock that generates rich soils and supports a high diversity of plants. Most of our time was spent in five moist meadows. Two of the meadows had abundant *Sanguisorba canadensis* and *Veronicastrum virginicum*, both of which were in bloom. A third meadow was thick with *Phlox maculata*, which still had a few flowers left. Other interesting plants in the meadows include two additional species of *Phlox* (*P. divaricata* and *P. paniculata*), five milkweeds (*Asclepias incarnata*, *A. purpurascens*, *A. syriaca*, *A. tuberosa*, and *A. viridiflora*), *Aletris farinosa*, *Arisaema dracontium*, *Campanula aparinoides*, *Ceanothus americanus*, *Galium obtusum*, *Gaura biennis*, *Heliopsis helianthoides*, *Hypoxis hirsuta*, *Ipomoea pandurata*, *Lilium canadense*, *Lyonia ligustrina*, *Mikania scandens*, *Mimulus alata*, *M. ringens*, *Scutellaria nervosa*, *Solidago speciosa*, and *S. rigida*. In one area, garden plants such as *Muscari sp.*, *Narcissus* sp., and *Vinca minor* imply former use as the site of a home.

The woods also hosted a high diversity of plants, including *Actaea racemosa*, *Aquilegia canadensis*, *Dirca palustris*, *Mitella diphylla*, *Oxalis violacea*, *Silene stellata*, and *Waldsteinia fragarioides*. Finally, around a boulder field, we saw *Corydalis sempervirens*, *Heuchera americana*, abundant *Polypodium* sp., and some very handsome lichens.

Attendance: 14. **Leaders: Joan King and Janet Novak. Report by the latter.**

01 August (Saturday): Savannahs of the Batsto River, Wharton State Forest of Burlington County, New Jersey.

At the Atsion Ranger Station along Route 206, we consolidated into 4-wheel drive vehicles and traveled southeast on Quaker Bridge Road to a branch trail that terminated at the Batsto River, site of an old bog iron forge. Occupying a sandy strip of exposed road shoulder were a few specimens of *Pityopsis falcata*, a station discovered about two decades ago.

In the vicinity we explored Lower Forge Savannah (aka "Ernie's Shoe" Savannah), a mineral–poor fen that appeared to have been a bog iron-ore excavation now dominated by a diverse number of *Sphagnum* species and an extensive quagmire core stained reddish-brown as a result of bog-ore regeneration. We noted *Sphagnum bartlettianum*, *S. pulchrum*, *S. tenerum*, *S. flavicomans*, *S. magellanicum*, *S. inundatum*, and the rare *S. potoricense*. As anticipated, we saw in athesis several specimens of *Platanthera clavellata*, two *P. blephariglottis* var. *conspicua*, two orange *P. cristata*, and a single, pale yellow *Platanthera* x *canbyi*^ (*P. blephariglottis* x *P. cristata*). Most of these orchids were well concealed in shrub thickets. *Pogonia ophioglossoides*, *Calopogon tuberosus*, and *Narthecium americanum* had already gone to seed.

Among the grasses, sedges, and rushes observed were *Andropogon glomeratus*, *Calamagrostis coactata* (=*C. cinnoides*), *Calamovilfa brevipilis*, *Muhlenbergia torreyana*, *M. uniflora*, *Carex barrattii*, *C. collinsii*, *C. exilis*, *C. folliculata*, *C. livida*, *C. striata*, *C. sticta*, *Cladium mariscoides*, *Eleocharis tuberculosa*, *Rhynchospora alba* (immature), *R. cephalantha*, *R. gracilenta*, *R. pallida*^ (globally rare), and *Scleria muehlenbergii* (immature).

We observed several flowering herbs: *Drosera filiformis*, *D. intermedia*, *D. rotundifolia*, *Eriocaulon decangulare*, *Eupatorium resinosum*^ (a single culm), *Hypericum canadense*, *H. denticulatum*, *Lilium superbum*, *Lobelia nuttallii*, *Lophiola aurea* (waning), *Nymphaea odorata*, *Polygala brevifolia*, *P. cruciata*, *Pondeteria cordata*, *Proserpinaca. pectinata*, *Rhexia virginica*, *Sabatia difformis*, *Triadenum virginicum*, *Utricularia striata*, *Xyris difformis* var. *difformis*, and *X. torta*^. Also noted were numerous colorful goblets of *Sarracenia purpurea*, a few tufts of *Schizaea pusilla*, and basal rosettes of *Eriocaulon aquaticum*. The *de novo* discovery at this site of a few flowering culms of the extremely rare *Ludwigia hirtella* (hairy Ludwigia) was a highlight. Charles F. Parker collected it on September 26, 1867 in nearby Atsion.

After eating lunch, we headed further south to "Lou Hand's Savannah" (aka Odd Spot), another sphagnous, mineral–poor fen that was much smaller than the above complex although equally rich in species. With the exception of those marked with a caret (^), we encountered here the same species as those listed above and added a few *Lobelia canbyi*, a single culm of *Xyris fimbriata*, *Smilax laurifolia*, *Rhynchospora chalarocephala*, *Dichanthelium dichotomum* var. *ensifolium*, and a fine stand of a little known composite *Sclerolepis uniflora*, projecting from shallow water with but a single plant still in flower. Exhibiting a few fruiting capsules, the *Narthecium americanum* occurrence appeared to be in decline.

To much of the group's delight, we saw >12 *Platanthera clavellata* within a woodline of *Acer rubrum* and *Chamaecyparis thyoides*. Nine *Platanthera cristata*, all in rich orange hue, were concealed in an *Ilex glabra*/ericaceous thicket. The most stunning display, however, was a large occurrence of > 50 plants of *Platanthera integra* still in bud in the open savannah.

We found no new species and no hybrid *Platanthera* for this site. We did find two small, new patches of *Schizaea pusilla* comprised of several tufts.

Thanks to Mark Szutarski and Donna Mc Bride for assistance with the plant list.

Attendance: 32. **Report by leader: Ted Gordon**

08 August (Saturday): Cumberland Pond, Manumuskin, and Head-of-River, Cumberland and Cape May Counties, New Jersey.

The trip began at Cumberland Pond along the Manumuskin River. Here the group botanized an open field adjacent to the pond and noted the following: *Andropogon virginicus*, *Asclepias tuberosa Desmodium marilandicum*, *D. paniculatum*, *Diodia teres*, *Eupatorium album*, *E. hyssopifolium*, *Euthamia tenuifolia*, *Lechea mucronata*, *Lespedeza angustifolia*, *Opuntia humifusa*, *Plantago aristata*, *Rubus cuneifolius*, *R. flagellaris*, *R. pensylvanicus, and Schizachyrium scoparium*. Good stands of the rare species *Desmodium strictum* were also noted in bloom. Two non-native wildflowers were observed, *Jasione montana*, with its showy blue flowers, and *Petrorhagia prolifera* with its small pink flowers. Four "tumbleweed" grasses – their inflorescences oftentimes breaking off later in the season and tumbling in the wind – were also noted: the non-native *Chloris verticillata;*

the common natives *Eragrostis spectabilis* and *Leptoloma* (*Digitaria*) *cognatum*, and the rare native *Gymnopogon ambiguus*. In a lower, moister area of the field, a small stand of *Platanthera lacera* was noted in fruit, as well as *Rhexia mariana* (along the drier edges of the depression) and *Rhexia virginica* (in the moister center areas of the depression) in bloom. In the boggy areas adjacent to the pond, the following species were noted: *Carex bullata*, *C. lurida*, *Decodon vertcillata*, *Drosera intermedia*, *D. rotundifolia*, *Dulichium arundinaceum*, *Juncus canadensis*, *Nymphaea odorata*, *Peltandra virginica*, *Sagittaria engelmanniana*, *Sarracenia purpurea*, *Thelypteris palustris* var. *pubescens*, and *Xyris difformis*.

The group then traveled along a power line cut west of Union Road. In the drier open areas, large stands of the rare *Croton wildenowii* (*Crotonopsis elliptica*) were observed. Other species noted here included: *Eurybia compacta* (*Aster gracilis*), *Epigaea repens*, *Eupatorium album*, *Hypericum gentianoides*, *Panicum virgatum*, *Pteridium aquilinum* var. *latiusculum*, *Quercus ilicifolia*, *Q. marilandica*, *Q. prinoides*, and *Q. stellata*. Further west along the power line, the group botanized an extensive open boggy marsh associated with the Manantico Creek and noted the following: *Andropogon glomeratus*, *Chasmanthium laxum* (limited to drier areas along edge of marsh), *Dulichium arundinaceum*, *Eleocharis obtusa*, *E. microcarpa*, *E. tenuis*, *E. tuberculosis*, *Eriophorum virginicum*, *Juncus canadensis*, *J. debilis*, *Osmunda cinnamomea*, *O. regalis* var. *spectabilis*, *Panicum longifolium*, *P. verrucosum*, *Rhexia virginica*, *Rhynchospora alba*, *R. capitellata*, *R. chalarocephala*, *R. gracilenta*, *R. macrostachya*, *Scleria triglomerata* (limited to drier areas on the edge), *Utricularia geminiscapa*, *U. striata*, *Viola lanceolata*, *V. primulifolia*, and *Woodwardia virginica*. A stand of the rare *Carex barrattii* and a few individuals of *Platanthera blephariglottis* in bloom were also noted. In the drier areas of the wetland, exceptionally large stands of *Polygala lutea* in full bloom were noted.

The group then traveled to an intermittent pond near Head-of-River in Cape May County. The pond was flooded with up to two feet of water in the center. The following species were noted: *Carex striata* (dominant along the outer margins of the pond), *Dulichium arundinaceum*, *Eleocharis microcarpa*, *Proserpinaca pectinata*, large stands of the rare *Rhynchospora inundata*, *Saccharum* (*Erianthus*) *giganteum*, one small stand of the rare *Sclerolepis uniflora*, the rare *Sphagnum macrophyllum* var. *macrophyllum* (chiefly submerged or floating in the water with only the tips emergent), the rare *Utricularia purpurea*, and large stands of *Xyris smalliana*. The material of *Rhexia* at this site was puzzling. Some of it appeared to be *Rhexia virginica*, while other specimens were intermediate between *R. virginica* and *R. aristosa* (see Snyder, *Bartonia* 59:63, footnote 3. 1996).

The group's final stop was the old Manumuskin railroad station area along Port-Cumberland Road. Here, in the open sandy areas adjacent to Virginia pine (*Pinus virginiana*) forests, the group saw good stands of the non-native *Ipomopsis rubra* with its showy red tubular flowers. This species has been known from this site since at least the late 1800s. *Monarda punctata* was also noted here in bloom, as well as the two rare species, *Desmodium strictum* and *Toxicodendron pubescens*. The group then walked east along the railroad toward the Manumuskin River. In the open sands, the unusual non-native grass *Tragus racemosus* was noted, its burred inflorescence being reminiscent of *Cenchrus* even though the two are not related. *Tragus* belongs the tribe *Cynodonteae* (=*Zoysieae*) and *Cenchrus* to the tribe *Paniceae*.

On approaching the fresh water tidal marshes adjacent to the Manumuskin River, the group noted a few specimens of *Crataegus uniflora*, the rare *Quercus michauxii*, and a single specimen of the rare *Chionanthus virginicus*. In the marshes, dominated chiefly by wild rice (*Zizania aquatica*), stands of the globally-imperiled *Aeschynomene virginica* in bloom were observed. Other rare species noted were *Elatine americana* and *Eriocaulon parkeri*. Additional species noted in the marsh included: *Apios americana*, *Eupatorium dubium*, *Ilex laevigata*, *I. verticillata*, *Leersia oryzoides*, *Lilium superbum*, *Lobelia cardinalis*, *Mikania scandens*, *Polygonum arifolium*, *Sambucus canadensis*, and *Vernonia noveboracensis*.

Many paticipants of the trip then traveled to the Delaware Bay and ate dinner at the Charlesworth Restaurant and Hotel in Fortescue.

Attendance: 26. **Report by leaders: Renée Brecht and Gerry Moore.**

20 September (Sunday): Pocono Glacial Till Barrens, Monroe County, Pennsylvania. Joint field trip with the Muhlenberg Botanical Society.

The Pocono till barrens, together with adjoining wetlands, forests and ridgetop barrens, host 125 species on Pennsylvania's endangered, threatened and rare list, 12 of which are imperiled globally. More than 8 square miles of native heathlands scattered along 30 miles of the Pocono Plateau's southern rim are remnants of a landscape managed for centuries by American Indians using fire. Participants hiked through adjoining nature preserves owned by Monroe County and the Bethlehem Water Authority and managed by The Nature Conservancy. The group explored dwarf-shrub savanna growing atop glacial till deposited more than 130,000 years ago by the Illinoian (second-to-last) glaciation. Dominant species were *Vaccinium angustifolium* (lowbush blueberry), *Kalmia angustifolia* (sheep-laurel), *Quercus ilicifolia* (scrub oak) and *Rhododendron canadense* (rhodora), with scattered *Pinus rigida* (pitch pine), *Viburnum cassinoides* (witherod), *Photinia melanocarpa* (black chokeberry), *Betula populifolia* (gray birch), *Picea rubens* (red spruce), *Amelanchier arborea* (common serviceberry), *A. laevis* (Allegheny serviceberry) and *A. stolonifera* (running serviceberry). We examined the results of barrens restoration and management by The Nature Conservancy using prescribed fire. Among the many species sighted were *Amianthium muscaetoxicum* (flypoison), *Calamagrostis cinnoides* (arctic reedgrass), *Carex polymorpha* (variable sedge), *Cornus canadensis* (bunchberry), *Dalibarda repens* (dewdrop), *Doellingeria umbellata* (flat-topped white aster), *Larix laricina* (tamarack), *Lycopodium hickeyi* (Pennsylvania clubmoss), *Piptatherum pungens* (mountain ricegrass), *Platanthera blephariglottis* (white fringed orchid), *Solidago puberula* (downy goldenrod) and *Vaccinium oxycoccos* (small cranberry). We also explored conifer swamp, several types of shrub swamp and the shore of Long Pond, an undammed glacial lake, where among others we added *Chamaedaphne calyculata* (leatherleaf), *Ilex mucronata* (mountain holly), *Myrica gale* (sweet gale), *Nuphar advena* (spatterdock), *Rhododendron viscosum* (swamp azalea), *Vaccinium corymbosum* (highbush blueberry) and *Viburnum recognitum* (northern arrow-wood) to the list of sightings. Near the end of the walk a small stand of *Eriophorum* was tentatively identified as *E. tenellum* (few-nerved cottongrass), a state-endangered species not reported before in the Long Pond area.

Attendance: 40, some from as far away as Warren, PA and Long Island. **Leaders: Roger Latham and Ann Rhoads. Report by the former.**

26 September (Saturday): Ramapo Mountains, Bergen and Passaic Counties, New Jersey.

This trip began at the New Jersey Botanical Garden. From here we entered the woodlands and began to climb over Defiance Ridge en route to Glasmere Ponds. Escapees that had become established in the woodlands were the shrubs *Deutzia scabra* and *Leucothoe* *fontanesiana* and young trees of *Magnolia tripetala*. In these forests, the following trees were observed: *Acer rubrum*, *A. saccharum*, *Betula alleghaniensis*, *Carpinus caroliniana* (small trees, large shrubs), *Carya glabra*, *C. tomentosa*, *Castanea dentata* (stump sprouts), *Cornus florida*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Nyssa sylvatica*, *Ostrya virginiana*, *Prunus serotina*, *Quercus alba*, *Q. montana*, *Q. rubra*, *Sassafras albidum*, and *Tilia americana*. Shrubs that were noted included: *Amelanchier arborea*, *Comptonia peregrina*, *Corylus cornuta*, *Hamamelis virginiana*, *Lindera benzoin*, *Vaccinium corymbosum*, *V. pallidum*, *V. stamineum*, *Viburnum acerifolium*, and *V. rafinesquianum*. The non-native *Berberis thunbergii* and *B. vulgaris* were both observed. Other species noted while walking over the ridge included: *Amphicarpaea bracteata*, *Aquilegia canadensis*, *Aralia nudicaulis*, *Carex rosea*, *Chimaphila maculata*, *Cinna arundinacea*, *Collinsonia canadensis*, *Cryptotaenia canadensis*, *Desmodium glabellum*, *D. glutinosum*, *D. paniculatum*, *Dichanthelium boscii*, *D. clandestinum*, *Epifagus virginiana*, *Eurybia divaricata*, *E. macrophylla*, *Goodyera pubescens*, *Ionactis linariifolius*, *Maianthemum canadense*, *Monotropa hypopithys*, *M. uniflora*, *Pyrola americana*, *Symphyotrichum cordifolium*, *S. racemosum*, *Thalictrum revolutum*, and *Uvularia sessilifolia*.

At Glasmere Ponds the group carefully examined the floating bladderwort that was frequent in one of the ponds. Based on the flower number, corolla structure, pedicels, and floats (see Reinert & Godfrey, *Amer. J. Bot.* 49: 213-220. 1962), it readily keyed to *Utricularia radiata*, which is rare in New Jersey. Other species noted in and around the ponds included: *Clethra alnifolia*, *Cornus amomum*, *Eutrochium fistulosum*, *Iris pseudacorus*, *Lyonia ligustrina*, the non-native invasive *Myriophyllum spicatum*, *Nymphaea odorata*, *Salix eriocephala*, and *Sparganium americanum*. Near the ponds but not in wetlands, the group was pleased to see specimens of *Aureolaria flava* and *Corallorhiza odontorhiza* in bloom.

After lunch the group climbed over Pierson Ridge en route to Spruce Swamp. During the climb the group encountered vegetation similar to what was observed in the climb over Defiance Ridge. In Spruce Swamp, the group did indeed see spruce, *Picea mariana* var. *mariana*, but it was exceptionally rare with only a few individuals for this northern species, which is infrequent in New Jersey. Other species that were noted during this brief survey included: *Alisma subcordatum*, *Carex crinita*, *C. lurida*, *Ilex laevigata*, *Cephalanthus occidentalis*, *Dulichium arundinaceum*, *Eleocharis obtusa*, *Glyceria striata*, *Hypericum mutilum*, *Juncus effusus*, *Lythrum salicaria*, *Polygonum punctatum*, *P. sagittatum*, *Scirpus cyperinus*, *S. georgianus*, and *Typha latifolia*.

Pteridophytes observed during the trip included: *Adiantum pedatum*, *Asplenium platyneuron*, *Athyrium filix-femina* var. *angustum*, *Dennstaedtia punctilobula*, *Dryopteris marginalis*, *Equisetum arvense*, *Onoclea sensibilis*, *Osmunda claytoniana*, *Phegopteris hexagonoptera*, *Polystichum acrostichoides*, *Pteridium aquilinum* var. *latiusculum*, *Thelypteris noveboracensis*, and *T. palustris* var. *pubescens*. The following goldenrods were in good bloom: *Euthamia graminifolia*, *Solidago altissima*, *S. bicolor*, *S. caesia*, *S. flexicaulis*, *S. juncea* (in fruit), and *S. rugosa*.

Attendance 17. **Report by leaders: Steve Glenn and Gerry Moore.**

2010

17 January (Sunday): Botany in Winter in Nottingham County Park, Chester County, Pennsylvania. Leaders: Jack Holt and Janet Ebert. No report received.

28 March (Sunday): Spring Break Botany- Notingham County Park, Chester County, Pennsylvania. Leaders: Jack Holt and Janet Ebert. No report received.

24 April: Stow Creek and Quinton, Cumberland and Salem Counties, New Jersey. This trip began at the Gum Tree Corner Wildlife Management Area in Stow Creek Township in Cumberland County. From here the group walked south along Canton Road (County Rt. 623) toward Willis Corner. Along the open roadsides adjacent to farm fields a good diversity of non-native crucifers (all native to Europe) was noted in flower and/or fruit, including: *Alliaria petiolata*, *Arabidopsis thaliana*, *Barbarea verna*, *B. vulgaris*, *Brassica nigra*, *Capsella bursa-pastoris*, *Cardamine hirsuta*, *Draba verna*, *Lepidium campestre*, and *Thlaspi arvense*. *Euphorbia helioscopa*, also native to Europe, was noted as well.

Further down the road at Willis Corner, the group botanized a rich mesic woodland of numerous spring wildflowers, including *Cardamine concatenata*, *Claytonia virginica*, *Erythronium americanum*, *Houstonia caerulea*, *Maianthemum canadense*, *M.* (*Smilacina*) *racemosum* (in bud), *Panax trifolius*, *Podophyllum peltatum* (mostly in bud), *Polygnatum biflorum* (in bud) and *Uvularia sessilifolia*. Good stands of *Diphasiastrum* (*Lycopodium*) *digitatum* and *Lycopodium obscurum* were observed. The stemless blue violets were carefully studied. *Viola papilionacea*, the common dooryard violet, was frequent along the roadsides, and was readily distinguished by its coarser habit, thicker rootstocks and darker blue flowers. *Viola affinis* was frequent in the mesic woodlands and was readily distinguished from *Viola papilionacea* (some treatments lump these two under the name *Viola sororia*), by its much more delicate habit, thinner rootstock, narrower leaves, and paler blue flowers. In the lower, wetter areas, *Viola cucullata* was noted, this species readily distinguished by its flowers being on long peduncles and having clavate trichomes on the lateral petals. Further back in the woodlands a population of *Listera australis* was found with a few dozen plants in bloom. One unusual specimen had two racemes present, the peduncle forking just above the pair of opposite, sessile leaves. The leaders noted that there were now 15 known populations in Cumberland County for this species, which was never reported from the county by earlier botanists, such as Bayard Long who collected extensively in Cumberland County in the early to mid 1900s. Trip attendants debated whether earlier botanists simply overlooked this orchid or whether the species' range is expanding and abundance increasing in southern New Jersey, which is toward the northern limit of the species' range on the Coastal Plain. Also noted here were several individuals of *Platanthera lacera*, which would bloom later in June.

The group then traveled to a powerline right-of-way, south of Quinton in Salem County to visit a population of the federally-threatened *Helonias bullata*. Flowering specimens were observed in the cut over right-of-way, as well as in the Atlantic white cedar (*Chamaecyparis thyoides*) swamps adjacent to the right of way. A few individuals of the rare *Chionanthus virginicus* were also observed in the cedar swamp. Along the edge of the drier oak-pine forests a few specimens of the rare *Malus angustifolia* were noted in bloom, as well a small stand of *Lycopodium lucidulum*, a species that is infrequently encountered on the Coastal Plain of southern New Jersey.

Attendance: 21. **Report by leaders: Renée Brecht and Gerry Moore.**

15 May (Saturday): Sussex Branch Trail, Sussex County, New Jersey. Joint trip with the Torrey Botanical Society.

We botanized along and near the Sussex Branch Trail north of Andover. This stretch of the trail, a converted rail line, goes through a limestone region, so the flora is quite rich. In the woods, we saw *Liparis liliifolia* in bud, and, in bloom, *Galearis spectabilis*, *Erigeron pulchellus*, *Geranium robertianum*, *Geranium maculatum*, *Hypoxis hirsuta*, *Orobanche uniflora*, and *Trillium cernuum*. We also saw a number of ferns, including *Adiantum pedatum*, *Asplenium rhizophyllum*, *Asplenium trichomanes*, *Botrychium virginianum*, *Cystopteris bulbifera*, *Dryopteris goldiana*, *Matteuccia struthiopteris*, and *Osmunda claytoniana*. In years past, several participants had seen *Chamaelirium luteum* in bloom, but we found only four plants, all of them too small to flower. A red maple swamp somewhat off the trail rewarded us with the vivid yellow flowers of a water buttercup, *Ranunculus flabellaris*. Also in the swamp were *Sium suave*, *Ranunculus hispidus*, *Dasiphora fruticosa* (*Potentilla fruticosa*), and *Veronica anagallis-aquatica* in bloom, as well as *Equisetum fluviatile*. On a talus slope we found *Adlumia fungosa*, and, on the cliff above, *Pellaea glabella*. Other species recorded were *Acer saccharum*, *Achillea millefolium*, *Actaea pachypoda*, *Alliaria petiolata*, *Allium tricoccum*, *Amelanchier* sp., *Amphicarpaea bracteata*, *Antennaria* sp., *Anthoxanthum odoratum*, *Aquilegia canadensis*, *Aralia nudicaulis*, *A. racemosa*, *Arisaema triphyllum*, *Artemisia vulgaris*, *Asclepias exaltata*, *Athyrium filix-femina*, *Berberis thunbergii*, *Caltha palustris*, *Carex gracillima*, *Carex stricta*, *Carpinus caroliniana*, *Caulophyllum thalictroides*, *Celtis occidentalis*, *Cerastium fontanum*, *Chelone glabra*, *Chimaphila maculata*, *Chrysosplenium americanum*, *Clematis* sp., *Conopholis americana*, *Cornus alternifolia*, *C. stolonifera*, *Dennstaedtia punctilobula*, *Deparia acrostichoides*, *Dioscorea* sp., *Dryopteris marginalis*, *Elaeagnus umbellata*, *Epipactis helleborine*, *Erigeron philadelphicus*, *Eurybia divaricata*, *Fragaria virginiana*, *Fraxinus nigra*, *Galium aparine*, *G. circaezans*, *G. lanceolatum*, *G. mollugo*, *Geum vernum*, *Hamamelis virginiana*, *Hepatica nobilis* var. *americana*, *Hesperis matronalis*, *Huperzia lucidula*, *Hypoxis hirsuta*, *Lilium* sp., *Lindera benzoin*, *Liriodendron tulipifera*, *Luzula* sp., *Lycopus* sp., *Lysimachia ciliata*, *L. nummularia*, *Maianthemum racemosum*, *Medeola virginiana*, *Menispermum canadense*, *Mitchella repens*, *Mitella diphylla*, *Monotropa uniflora*, *Onoclea sensibilis*, *Orobanche uniflora*, *Osmorhiza longistylis*, *Osmunda cinnamomea*, *Packera aurea*, *P. obovatus*, *Panax trifolius*, *Peltandra virginica*, *Phegopteris hexagonoptera*, *Podophyllum peltatum*, *Polygonatum pubescens*, *Polygonum virginianum*, *Polypodium* sp., *Polystichum acrostichoides*, *Prenanthes* sp., *Pyrola elliptica*, *Quercus bicolor*, *Q. muehlenbergii*, *Ranunculus abortivus*, *R. recurvatus*, *Rhus typhina*, *Rubus odoratus*, *R. phoenicolasius*, *Sanguinaria canadensis*, *Sanicula* sp., *Solidago caesia*, *Staphylea trifolia*, *Symplocarpus foetidus*, *Taraxacum* sp., *Thalictrum pubescens*, *T. thalictroides*, *Thelypteris noveboracensis*, *T. palustris*, *Toxicodendron radicans*, *Tsuga canadensis*, *Uvularia perfoliata*, *Viburnum acerifolium*, *V. prunifolium*, *Viola cucullata*, *V. labradorica*, *V. pensylvanica*, *V. pubescens*, and *V. sororia*.

Attendance: 18. **Leaders: David Austin and Janet Novak. Report by the latter.**

05 June (Saturday): Unionville Serpentine Barrens, Chester County, Pennsylvania. Joint field trip with the Muhlenberg Botanical Society.

Participants carpooled to the entrance of the Unionville Barrens on a hot afternoon. The trip leader, Roger Latham, began by describing the geologic origin and makeup of serpentinite, a metamorphosed igneous ocean-floor bedrock formation, the tectonic events that led to its presence on dry land, and the circumstances that allowed the Natural Lands Trust (NLT) to acquire more than half of the barrens area in 2008. He explained how NLT's stewardship staff is embarking on a long-term grassland restoration program to reverse declines in rare species. The losses are attributed to fire exclusion allowing invasion by trees and *Elaeagnus umbellata* (autumn olive), reducing the grassland area by 90 percent over the past 80 years.

We then plunged into the woodlands, and in a few minutes came upon our first patch of open serpentine barren, where we examined numerous examples of its unique flora, including a large colony of *Deschampsia cespitosa* (tufted hairgrass), *Lobelia spicata* (spiked lobelia), *Oenothera fruticosa* (sundrops) and some of the ubiquitous and signature species of serpentine barrens, *Cerastium velutinum* (barrens chickweed), *Schizachyrium scoparium* (little bluestem) and *Phlox subulata* (moss phlox). We then made a stop along the banks of Feldspar Run, which bisects the barrens. Here the leader talked about the site's recent history, including the mining operation that gave it its former name "Corundum Hill" and the uses of that mineral and other minerals that came from it and the other barrens, most notably chromium, which at the time was used mostly to produce the paint color chrome yellow. We then walked up a hill and came to one of the larger open barrens, dominated by a thin low-growing turf of warm-season grasses and serpentine-restricted species, including enormous amounts of *Symphyotrichum depauperatum* (serpentine aster) and *Scleria pauciflora* (few-flowered nutrush). Moving eastward we came to a second smaller patch of grassland, where in the middle of a collapsed mine shaft grew a single specimen of *Quercus nigra* (water oak). There was considerable discussion among the group as to how the tree got there, well north of its typical northern range of extreme South Jersey and the central Delmarva. Although yellow-leaved the tree was apparently healthy, having grown since 2002 (when first discovered) from 5 feet to 20 feet in height.

During yet another sojourn through more woods, we found growing near the edge small colonies of *Aristolochia serpentaria* (Virginia snakeroot), *Calystegia spithamaea* (low bindweed) and *Sericocarpus asteroides* (white-topped aster). After that we visited a third open grassland, where grew considerable quantities of *Sisyrinchium mucronatum* (needletip blue-eyed-grass) in full flower. Heading downslope toward the road, we passed through one last stretch of open ground, encountering *Dichanthelium oligosanthes* (Heller's witchgrass), *Lespedeza virginica* (slender bush-clover) and *Pycnanthemum tenuifolium* (narrow-leaf mountain-mint), among other species.

Plant list: *Acer rubrum, Achillea millefolium, Agrostis perennans, Ailanthus altissima, Ambrosia artemisiifolia, Amelanchier arborea, Antennaria plantaginifolia, Anthoxanthum odoratum, Apios americana, Apocynum cannabinum, Arabis lyrata, Arisaema triphyllum, Aristolochia serpentaria, Asclepias verticillata, A. viridiflora, Asplenium platyneuron, Athyrium filix-femina, Baptisia tinctoria, Berberis thunbergii, Botrypus virginianus, Calystegia spithamaea, Carduus nutans, Carex blanda, C. digitalis, C. glaucodea, C. hirsutella, C. pensylvanica, C. swanii, Celastrus orbiculatus, Cerastium velutinum, Chimaphila maculata, Circaea canadensis, Clematis virginiana, Commelina communis, Cornus florida, Danthonia spicata, Dennstaedtia punctilobula, Deschampsia cespitosa, Dianthus armeria, Dichanthelium acuminatum, D. clandestinum, D. depauperatum*(?), *D. oligosanthes, D. sphaerocarpon, Dryopteris carthusiana, D. intermedia, Elaeagnus umbellata, Eleocharis tenuis, Epigaea repens, Euonymus alatus, Ageratina aromatica, Eurybia divaricata, Euthamia graminifolia, Fagus grandifolia, Galium circaezans, G. pilosum, G. triflorum, Gaylussacia baccata, Hieracium venosum, Houstonia caerulea, Hypericum punctatum, Ilex opaca,*

Impatiens capensis, *Isotria verticillata*, *Juglans nigra*, *Juncus secundus*, *Juniperus virginiana*, *Leersia virginica*, *Lespedeza virginica*, *Lindera benzoin*, *Liriodendron tulipifera*, *Lobelia spicata*, *Lonicera japonica*, *L. morrowii*, *Maianthemum racemosum*, *Saxifraga virginiensis*, *Microstegium vimineum*, *Minuartia michauxii*, *Mitchella repens*, *Nyssa sylvatica*, *Oenothera fruticosa*, *O. perennis*(?), *Osmunda claytoniana*, *Oxalis dillenii*, *Packera anonyma*, *Parthenocissus quinquefolia*, *Persicaria longiseta*, *Phemeranthus teretifolius*, *Phlox subulata*, *Phytolacca americana*, *Poa pratensis*, *Polygonatum biflorum*, *Persicaria virginiana*, *Polystichum acrostichoides*, *Populus grandidentata*, *Potentilla canadensis*, *Prunella vulgaris*, *Prunus avium*, *P. serotina*, *Pteridium aquilinum*, *Pycnanthemum tenuifolium*, *Quercus alba*, *Q. coccinea*, *Q nigra*, *Q. prinoides*, *Q. stellata*, *Q. velutina*, *Rhododendron periclymenoides*, *Rosa carolina*, *R. multiflora*, *Rubus allegheniensis*, *R. phoenicolasius*, *Rumex acetosella*, *R. obtusifolius*, *Sabatia angularis*, *Sanicula canadensis*, *Sassafras albidum*, *Schizachyrium scoparium*, *Scirpus* sp., *Scleria pauciflora*, *Sericocarpus asteroides*, *Sisyrinchium mucronatum*, *Smilax herbacea*, *S. glauca*, *S. rotundifolia*, *Solanum carolinense*, *Solidago rugosa*, *Sorghastrum nutans*, *Sphenopholis obtusata*, *Symphyotrichum depauperatum*, *S. lateriflorum*, *S. pilosum*, *Symplocarpus foetidus*, *Taraxacum officinale*, *Thelypteris noveboracensis*, *Toxicodendron radicans*, *Trichophorum planifolium*, *Vaccinium pallidum*, *V. stamineum*, *Viburnum acerifolium*, *V. dentatum*, *V. prunifolium*, *V. setigerum*, *Viola sagittata*, *Vitis vulpina*.
Attendance: 20. **Leader: Roger Latham. Report by Jack Holt.**

12 June (Saturday): Edwin B. Forsythe National Wildlife Refuge, Barnegat Division Forked River and vicinity, Ocean County, New Jersey. Joint trip with Torrey Botanical Society. Leader: Linda Kelly. No report received.

20-24 June (Sunday-Thursday): Buxton School, Williamstown in Berkshire County, Massachusetts.

Joint Annual Field Meeting of the Botanical Society of America (Northeastern Section), the Philadelphia Botanical Club, and the Torrey Botanical Society.

The meeting was held at Buxton School, a small private high school in Williamstown, in northern Berkshire County, Massachusetts. A few participants elected to stay at accommodations nearby. Although not able to join us, C. Barre Helquist, Biology Professor Emeritus, Massachusetts College of Liberal Arts, assisted the chairperson in selecting field trip sites. Pam Weatherbee, a Berkshire County botanist, also helped with the planning and served as a primarily field leader. Instead of receiving the usual plant lists, each participant was provided with a copy of Pam's fine illustrated book, *Flora of Berkshire County*.

Sunday evening **Pam Weatherby** gave a fine introduction to Berkshire County and showed slides of major Berkshire features, flora, and early naturalists.

Monday we left by school bus for Greylock, the highest mountain in Massachusetts with its unique sub-alpine boreal forest. We stopped on the way to see the endangered hairy honeysuckle (*Lonicera hirsuta*). At the base of the mountain, Pam led us up the Appalachian Trail a short distance to see the rare broad-leaved waterleaf (*Hydrophyllum canadense*) in an area that had many other rich-soil plants. Higher up the mountain, we stopped at the site of farmer "Jeremiah Wilbur's Clearing," an historic farm of the late 1700s. Additional stops were made amidst traffic to photograph scenic views, the geology in a new road cut, and mountain cranberry (*Vaccinium vitis-idaea*), growing in a small patch. Our lunch stop at the top offered fine views amid krummholz balsam and other wildflowers. Pam pointed out the differences between the mountain ash (*Sorbus americana*) and the rare northern mountain ash (*Sorbus decora*) that blooms earlier. Also we saw the rare Bartram's shadbush (*Amelanchier bartramiana*). In the afternoon we descended the mountain part-way, and Pam took us up the old Dynamite Trail where the CCC used to store their dynamite for construction purposes building the early roads and the lodge on the mountaintop. On this trail we saw swamp red currant, (*Ribes triste*), the rare woodland millet (*Milium effusum*) and various ferns. Up along the brook we climbed to see a lovely tall specimen of Braun's holly fern (*Polystichum braunii*) and the rare bristly black currant (*Ribes lacustre*). At our final stop at the Trustees of Reservations Field Farm in Williamstown we hiked a calcareous trail dominated by a diverse sedge flora.

Monday evening our speaker was Geoscience Professor **Paul Karabinos** of Williams College whose topic was, "The Geologic History of Western Massachusetts – How Plate Tectonics and Glaciation Influence Plant Communities." He explained the interesting geology of Berkshire County, which has areas of very old granites and gneisses, marbles and quartzite and schist. His geology map showed a ribbon of marble under the Dynamite Trail, explaining the rich and rare flora that we had seen that afternoon, and also the acid rocks under the less interesting areas. He commented on the special road cut that folks had spotted that morning.

On Tuesday we went directly to Bartholomew's Cobble, a National Natural Landmark, in Sheffield, about an hour and a half bus ride. The Trustees of Reservations staff welcomed us, and two leaders each took a group around the cobble area with its excellent variety of ferns and rich-soil plants. After lunch on the lawn, we again divided into groups to see more of the area.

On the return trip, we stopped at a sheep farm where we watched the farmer call his sheep from the high pasture to the barnyard. We then hiked through fields to a calcareous wetland to see a fine patch of showy lady's slipper (*Cypripedium reginae*). Deer have decimated most other lady's slipper sites in Massachusetts.

Tuesday night, **Robynn Shannon**, a research botanist from Connecticut, presented a talk "Botanical Taxonomy and Nomenclature: How and Why Taxonomists Make Your Life Difficult."

Wednesday we set out for Stockbridge and Kampoosa Bog. At the first stop along the way, we saw an example of black maple with low branches allowing us to examine leaves and compare them to sugar maple. The Massachusetts Fish and Game Department gave us permission to visit Kampoosa Bog, which is technically a lake basin graminoid, calcareous fen, containing one of the state's most significant rare species habitats. The water level was relatively high and the route muddy. Although it was early in the season, we saw several interesting species including bog birch (*Betula pumila*), alpine bulrush (*Trichophorum alpinum*) and two species of orchids, rose Pogonia (*Pogonia ophioglossoides*) and shining lady's-tresses (*Spiranthes lucida*).

We had our lunch on the campus of Tanglewood and in the afternoon walked the trails at the nearby Bullard Woods (Stockbridge) to see the impressive collection of big trees and woodland flowers. On the return trip, we stopped to explore a calcareous meadow in the town of Richmond.

Our final banquet dinner was followed by a delightful illustrated talk about "The Nature of New England" by **Tom Tyning**, Environmental Science Professor from Berkshire Community College.

List of Species Observed:

Pine Cobble: Hairy honeysuckle (*Lonicera hirsuta*) and New Jersey tea (*Ceanothus americanus*).

Appalachian Trail: white avens (*Geum canadense*), purple flowering raspberry (*Rubus odoratus*), tall meadow rue (*Thalictrum pubescens*), hog peanut (*Amphicarpa bracteata*), dwarf raspberry (*Rubus pubescens*), Solomon's plume (*Maianthemum racemosum*), red baneberry (*Actaea rubra*), partridgeberry (*Michella repens*), red-berried elder (*Sambucus pubens*), red trillium (*Trillium erectum*), broad-leaved waterleaf (*Hydrophyllum canadense*), Virginia waterleaf (*Hydrophyllum virginianum*), wood nettle (*Laportea canadensis*), silvery spleenwort (*Deparia acrostichoides*), and royal fern (*Osmunda regalis*).

Wilbur's Clearing: red spruce (*Picea rubens*), bluebead lily (*Clintonia borealis*), whorled aster (*Oclemena acuminata*), bush honeysuckle (*Diervilla lonicera*), rosybells (*Streptopus roseus*), Indian cucumber root (*Medeola virginiana*), blackberry (*Rubus allegheniensis*), lowbush blueberry (*Vaccinium angustifolium*), goldthread (*Coptis trifolia*), hobblebush (*Viburnum alnifolium*), wild sarsaparilla (*Aralia nudicaulis*), and tree clubmoss (*Lycopodium obscurum*).

Greylock Summit: heart-leaved birch (*Betula papyrifera* var. *cordifolia*), mountain cranberry (*Vaccinium vitis-idaea*), mountain ash (*Sorbus americana*), northern mountain ash (*Sorbus decora*), Bartram's shadbush (*Amelanchier bartramiana*), blue-eyed grass (*Sisyrinchium* sp.), yellow rattle (*Rhinanthus crista-galli*), sheep laurel (*Kalmia angustifolia*), and balsam fir (*Abies balsamea*).

Dynamite Trail: swamp red currant (*Ribes triste*), northern lady fern (*Athyrium filix-femina*), woodland millet (*Milium effusum*), Braun's holly fern (*Polystichum braunii*), bristly black currant (*Ribes lacustre*).

Field Farm: Creeping spikemoss (*Selaginella apoda*), penstemon (*Penstemon digitalis*), and pendulous bulrush (*Scirpus pendulus*).

Bartholomew's Cobble: maidenhair spleenwort (*Asplenium trichomanes*), rock polypody (*Polypodium appalachianum*), marginal woodfern (*Dryopteris marginalis*), blunt-lobed Woodsia (*Woodsia obtusa*), evergreen wood fern (*Dryopteris intermedia*), bulblet fern (*Cystopteris bulbifera*), walking fern (*Asplenium rhizophyllum*), fly honeysuckle (*Lonicera canadensis*), bloodroot (*Sanguinaria canadensis*), wild ginger (*Asarum canadense*), Herb Robert (*Geranium robertianum*), ostrich fern (*Matteuccia struthiopteris*), bladdernut (*Staphylea trifolia*), false hellebore (*Veratrum viride*), Canada lily (*Lilium canadense*), narrow-leaved spleenwort (*Diplazium pycnocarpon*), Goldie's fern (*Dryopteris goldiana*), wild cucumber (*Echinocystis lobata*), sweet cicely (*Osmorhiza claytonii*), blue cohosh (*Caulophyllum thalictroides*), maidenhair fern (*Adiantum pedatum*),cut-leaved toothwort (*Cardamine concatenata*), white baneberry (*Actaea pachypoda*), honewort (*Cryptotaenia canadensis*), silvery spleenwort (*Deparia acrostichoides*), Christmas fern (*Polystichum acrostichoides*), hooked crowfoot (*Ranunculus recurvatus*), thimbleweed (*Anemone cylindrica*), golden Alexanders (*Zizia aurea*), pagoda dogwood (*Cornus alternifolia*), yellow oak (*Quercus muhlenbergii*), purple cliff-brake (*Pellaea atropurpurea*), harebell (*Campanula rotundifolia*), columbine (*Aquilegia canadensis*), hackberry (*Celtis occidentalis*), red cedar (*Juniperus virginiana*), wild garlic (*Allium canadense*), box elder (*Acer negundo*), common milkweed (*Asclepias syriaca*), wild bergamot (*Monarda fistulosa* var. *fistulosa*), motherwort (*Leonurus cardiaca*), fragile fern (*Athyrium tenuis*), carrion-flower (*Smilax herbacea*), butternut (*Juglans cinerea*), English plantain (*Plantago lanceolata*), mountain laurel (*Kalmia latifolia*), moonseed (*Menispermum canadense*), and *Scirpus* sp.

Farm: showy lady's slipper (*Cypripedium reginae*).

Carey Corner Fen: shining lady's tresses (*Spiranthes lucida*), horsetail (*Equisetum variegatum*), autumn willow (*Salix serissima*), water avens (*Geum rivale*).

Kampoosa Field: Bladder campion (*Silene vulgaris*), Indian hemp (*Apocynum cannabinum* var. *cannabinum*), maiden pink (*Dianthus deltoides*), devil's paintbrush (*Hieracium aurantiacum*).

Kampoosa Bog: Bog birch (*Betula pumila*), sweet gale (*Myrica gale*), shrubby cinquefoil (*Dasiphora fruiticosa* subsp. *floribunda*), large cranberry (*Vaccinium macrocarpon*), bog bean (*Menyanthes trifoliata*), bog rosemary (*Andromeda polifolia* var. *glaucophylla*), rose Pogonia (*Pogonia ophioglossoides*), alpine bulrush (*Scirpus hudsonianus*), hoary willow (*Salix candida*), *Carex aquatilis*, and northern bladderwort (*Utricularia intermedia*).

Bullard's Woods: tulip tree (*Liriodendron tulipifera*), shagbark hickory (*Carya ovata*), pignut hickory (*Carya glabra*), sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), and white oak (*Q. alba*).

Attendance: 38. **Report by chairperson: Nancy N. Williams.**

10 July (Saturday): Botany of the Pinelands of southern New Jersey. Atsion Area.

This was the first in a series of trips that focused on the characteristic plants of the Pinelands. The trips enumerated below were only open to members of the Philadelphia Botanical Club and the students registered in the Pinelands Preservation Alliance's (PPA) special Pinelands Plants Course under the leadership of **Russell Juelg.** Instead of a report on each field trip, a single non-traditional summary of all trips conducted by the PPA in 2010 and 2011 occurs under the date of 12 June, 2011.

Other Trip Dates:

18 July (Sunday): Atsion area; **24 July (Saturday):** Batsto area-rare plant management project;

01 August (Sunday): undisturbed "paleodunes" near Chatsworth; **15 August (Sunday):** Atsion ore fields;

21 August (Sunday): Lower Forge; **29 August (Sunday):** Atsion and "Above the Locks," Mullica River.

22 July (Thursday): Fern Identification Workshop, Academy of Natural Sciences, Philadelphia.

This workshop covered the characteristics that allow identification of some of the ferns of New Jersey and southeastern Pennsylvania, using fresh fronds as illustration. We covered around 30 ferns, including nearly all the region's common ferns (e.g. *Athyrium filix-femina*, *Thelypteris noveboracensis*) and a few somewhat uncommon ferns (e.g. *Cystopteris protrusa*, *Dryopteris clintoniana*). Thanks go to Jack Schieber, for supplying fronds from his garden, and to the Botany Department at the Academy of Natural Sciences, for lending microscopes.

Attendance: approximately 15. **Report by leader: Janet Novak.**

07 August (Saturday): Maurice River, Millville, Vineland, Cumberland County, New Jersey. Joint trip with Torrey Botanical Society and R. Juelg's Botany of the Pinelands class.

The trip began along the Maurice River in Millville's Sharp Street Park just below the Union Lake dam. Here the group walked along the western entrance of the Maurice River Walk, a series of trails and pedestrian bridges recently installed by the City of Millville.

Botanizing began in a mixed pine-oak woodland. Oaks noted here included: *Quercus alba*, *Q. falcata*, *Q. montana*, *Q. phellos*, *Q. stellata*, and *Q. velutina*. Unusual material that possibly represented hybridization between *Q. phellos* and perhaps *Q. falcata* was studied. The pines were also a source of discussion with some material being intermediate (as reported by P. E. Smouse & L. C. Saylor, *Annals Missouri Bot. Gard.* 60: 174--203. 1973) among three species, *Pinus rigida*, *P. taeda*, and *P. serotina*, the latter two species rare in New Jersey and reaching the northern limits of their native ranges in southern New Jersey. *Pinus echinata* and *P. virginiana* were also observed. A few specimens of *Cypripedium acaule* were noted under the pines, as well as *Chimaphila maculata*. Two hickories, *Carya pallida* and *C. tomentosa* were also noted. The group also investigated a palustrine swamp in the woodlands and noted the following: *Cardamine pensylvanica*, *Fraxinus americana* (few specimens), *Ilex vertcillata*, *Impatiens capensis* (large stands), *Liquidambar styraciflua*, *Nyssa sylvatica*, *Onoclea sensibilis*, *Osmunda cinnamomea*, *O. regalis* var. *spectabilis*, *Pilea pumila*, *Rhododendron viscosum*, *Salix nigra*, *Symplocarpus foetidus*, *Toxicodendron vernix* (1 individual), *Viburnum dentatum*, *Viola cucullata*, *Woodwardia areolata*, and *W. virginica*. A few individuals of the rare *Chionanthus virginicus* were also noted. Along the trail numerous non-native species have become established, including: *Acer platanoides*, *Ailanthus altissima*, *Albizia julibrissin*, *Artemisia vulgaris*, *Broussonetia papyrifera*, *Catalpa bignonioides*, *Celastrus orbiculatus*, *Clematis terniflora*, *Coronilla* (*Securigera*) *varia*, *Euonymus alatus*, *Lonicera japonica*, *L. morrowii*, *Microstegium vimineum*, *Polygonum cuspidatum* (*Fallopia japonica*), *Morus alba*, *Robinia pseudoacacia*, *Rosa multiflora*, *Salix atrocinerea*, and *Viburnum lantana*.

The group also spent much time botanizing in the open freshwater tidal marshes along the river. Despite being in the heart of downtown Millville with a history of much industry, the group was impressed to see such an excellent example of this rare habitat type. Species noted in the marsh included: *Alnus serrulata*, *Apios americana*, *Aronia arbutifolia*, *Asclepias incarnata*, *Betula nigra*, *Boehmeria cylindrica*, *Carex lurida*, *C. stricta*, *Chamaecyparis thyoides*, *Chelone glabra*, *Clethra alnifolia*, *Cornus amomum*, *Decodon verticillatus*, *Dulichium arundinaceum*, *Eupatorium dubium*, *E. perfoliatum*, *Hibiscus moscheutos*, *Hypericum densiflorum*, *H. mutilum*, *Iris versicolor*, *Juncus effusus*, *Leersia oryzoides*, *Lilium superbum*, *Ludwigia alternifolia*, *L. palustris*, *L. sphaerocarpa*, *Lycopus americanus*, *Lyonia ligustrina*, *Magnolia virginiana*, *Mimulus ringens*, *Nuphar advena*, *Orontium aquaticum*, *Oxypolis rigidior*, *Peltandra virginica*, *Polygonum arifolium*, *P. hydropiperoides*, *P. punctatum*, *P. sagittatum*, *Pontederia cordata*, *Sagittaria latifolia*, *Sambucus canadensis*, *Scutellaria galericulata*, *S. lateriflora*, *Sium suave*, *Sparganium americanum*, *Spiraea tomentosa*, *Thalictrum pubescens*, *Vaccinium corymbosum*, *Vernonia noveboracensis*, and *Zizania aquatica*. In one area a large stand of *Helenium autumnale* – a species infrequently encountered in Cumberland County – was present; Witmer Stone (see p. 775 in his *Plants of Southern New Jersey*) discussed the peculiar distribution of this plant in the state. *Gratiola aurea* was also present in the marshes, and this material was larger in all aspects from the typical *Gratiola aurea* material found in non-tidal areas (including in sandy non-tidal wetlands along the Maurice River in the nearby Union Lake area). F. W. Pennell (Torreya *19:* 145. 1920) referred to this tidal form as *Gratiola aurea* var. *obtusa*. Cattails were frequent, with most material referable to *Typha* × *glauca*, although *T. angustifolia* and *T. latifolia* were also observed.

Besides the thickly vegetated marshes, the group also botanized the extensive areas of exposed mud flats that were present along the Maurice River below the dam. The substrate of these flats varied from gravel, sand, to silt. These flats were best surveyed at low tide when they were maximally exposed. Excellent areas to botanize, these exposed open flats, consisting of green "lawns" (this term used by Samuel S. Van Pelt, Curator of the Philadelphia Botanical Club from 1904-1913 on some of his collection labels for similar areas he explored along the Delaware River in the early 1900s) of rare plants, specifically *Elatine americana*, *Eriocaulon parkeri*, and *Isoëtes riparia*. Other species noted here in lesser abundance were the rare *Gratiola virginica* and *Lindernia dubia*, both species represented by material with chiefly cleistogamous flowers, these tidal forms being described by Francis Pennell (*Monogr. Acad. Nat. Sci. Philadelphia* 1. 1935) as *Gratiola virginiana* var. *aestuariorum* (p. 96) and *Lindernia dubia* subsp. *major* var. *inundata* (pp. 151-152), respectively. *Callitriche heterophylla* was also noted.

The small *Sagittarias* in the flats were carefully examined, and it was determined that most of the material was referable to the submerged form (the plants being submerged at high tide) of *Sagittaria graminea* subsp. *graminea*. This material differs from the emergent form of *Sagittaria graminea* subsp. *graminea* in having the leaf blades chiefly replaced by spongy phyllodia and in lacking fruit (see Stone's account on p. 172 in his *Plants of Southern New Jersey*). Previously, such submerged forms had been recognized as distinct species, *S. edwardsiana* R.T. Clausen (see *Rhodora* 39: 29--31. 1937; named in honor of noted botanist from Montclair J. L. Edwards, and typified by material collected from non-tidal areas along a branch of the Wading River north of Washington in Burlington County, New Jersey) and *S. eatonii* J. G. Smith (see *Annals Missouri Bot. Gard.* 11: 150--151. 1900; typified by material from freshwater tidal areas of the Merrimac River in Newburyport in Essex County, Massachusetts). Other *Sagittaria* individuals possessed mature pistillate flowers on recurved pedicels and were clearly referable to the rare *Sagittaria subulata*. Most of the species observed in the mud flats were also observed in the tidal marshes but were much less abundant.

In a few places in the mud flats, stands of a small *Cardamine* were observed. These plants had flowers that were apetalous or with greatly reduced petals and reduced leaves possessing only one or two pairs of leaflets. This material was somewhat suggestive of the globally rare *Cardamine longii*. However, after further study it was concluded that it likely represented a tidal form of *C. pensylvanica*, which was previously observed in the nearby non-tidal wetlands. Also observed in the tidal flats was a stand of sterile *Hydrocotyle*, later identified as the rare *H. verticillata* var. *verticillata*. Other plants noted in the mud flats that usually are not associated with this habitat type included: *Agalinis purpurea*, *Rhexia virginica*, *Rubus pensilvanicus* (low growing material), and *Xyris difformis*, all four species being submerged at high tide.

The riverbanks of the freshwater tidal zone at low tide also provided noteworthy botanical finds. Along the banks in the tidal zone *Selaginella apoda* was abundant. Also noted were the following bryophytes: *Fissidens dubius*, *Fontinalis novae-angliae*, and *Riccia fluitans*. In the river, the following aquatics were observed: *Potamogeton diversifolius* and the rare *Utricularia gibba*.

While the group was thoroughly impressed with these habitats along the Maurice River in downtown Millville, which harbored populations of ten rare plant species and unusual tidal forms and species assemblages, other findings were of concern. Not surprisingly, stands of the invasive *Phragmites australis* subsp. *australis* were present in places. Also, large stands of a sterile commelinaceous plant were observed at four different locations in the freshwater tidal marshes. While this material was unidentifiable on the day of the trip, subsequent trips by the trip leaders and Douglas Goldman of Harvard University Herbaria, resulted in the discovery of flowering material, allowing it to be identified as the highly invasive *Murdannia keisak*. Prior to this discovery, this species, native to eastern Asia, was not known in the U.S. north of Sussex County, Delaware. A population of *Kyllinga gracillima*, native to Asia, was also noted, and this represented the first report of this species from Cumberland County. During a later trip, the trip leaders also discovered in a freshwater tidal marsh below where the group botanized, a population of the highly invasive mile-a-minute (*Polygonum perfoliatum*), a species also previously not reported from Cumberland County.

After a late lunch the group traveled north to Vineland to botanize a white cedar swamp and boggy wetland adjacent to the Maurice River along Sherman Avenue. In the cedar swamp south of Sherman Avenue, the group observed a population of the federally-threatened *Helonias bullata*. Other species noted here included: *Acer rubrum*, *Carex collinsii*, *C. howei*, *Drosera rotundifolia*, *Ilex laevigata*, *I. verticillata*, *Orontium aquaticum*, *Trientalis borealis*, and *Viburnum nudum*.

The group then crossed the road to explore a bog, whose quaking nature made exploration of it a challenge, some choosing to crawl on all fours. Nonetheless, it was worth the effort as the globally rare species *Juncus caesariensis* and *Schizaea pusilla* (discovered by Janet Novak) were found, the latter last collected from here by Bayard Long in the 1930s with sight records going into the 1960s. Recent efforts to find *Schizaea* at this site – one of only two historical locations for *Schizaea* from Cumberland County – had not been successful. Other species noted in the bog included: *Drosera intermedia*, *Dulichium arundinaceum*, *Eriocaulon compressum*, *E. decangulare*, *Nymphaea odorata*, *Platanthera blephariglottis*, *Pogonia ophioglossoides*, *Polygala brevifolia*, *P. cruciata*, *Rhynchospora alba*, *Sarracenia purpurea*, *Utricularia striata*, and *Vaccinium macrocarpon*.
Attendance: 21. **Report by leaders: Gerry Moore and Renée Brecht.**

11 September (Saturday): Pitch Pine Lowlands of Atsion-Dutchtown Vicinity and Wescott Bogs, Wharton State Forest, Burlington and Atlantic Counties, New Jersey.

Initial plans to visit selected savannahs of the Batsto River were abandoned because a scouting trip to those sites revealed that none of the target species (e.g., *Spiranthes laciniata*, *Eupatorium leucolepis*, *Xyris fimbriata*) were found. Botanizing commenced at "Gentian Cove" along the abandoned Jersey Central line at Atsion. Regrettably, what once was a vigorous population of *Gentiana autumnalis* here has in recent years (with the exception of 2009) declined to a few wilted, often aborted, specimens. These were the conditions that prevailed at our early visit. Onset of this degeneration appeared to have coincided with canopy closure an estimated ten years ago, although conditions of drought played a vital role as well. Timely removal of the *Pinus rigida* and selected shrub overstory would likely have benefitted this gentian population whose survival at this site appeared in jeopardy. Other species observed in the vicinity included *Amphicarpum purshii*, *Aristida virgata*, *Calamovilfa brevipilis*, *Glyceria obtusa*, *Muhlenbergia torreyana*, *Panicum scoparium*, *P. virgatum*, *Schizachyrium scoparium*, *Carex barrattii*, *C. livida*, *Rhynchospora capitellata*, *R. chalarocephala*, *R. pallida* (2 plants), *R. torreyana*, *Fimbristylis puberula* var. *puberula*, *Juncus biflorus*, *J. dichotomus*, *J. scirpoides*, *Croton willdenowii*, *Eurybia compacta* (=*Aster gracilis*),*Eupatorium pilosum*, *Hypericum stans*, *Vaccinium corymbosum*, *Leiophylum buxifolium*, *Lyonia mariana*, *Leucothoe racemosa* (=*Eubotrys racemosa*), *Pyxidanthera barbulata*, *Iris prismatica*, *Lobelia nuttallii*, *Calopogon tuberosus*, *Polygala lutea*, *Solidago* *stricta* (1 plant), *Cephalanthus occidentalis*, *Diodia teres*, *Decodon verticillatus*, and *Mikania scandens*.

The discovery of five species of the genus *Ludwigia* on a patch < ¼ acre in size appeared noteworthy.

We saw *Ludwigia alternifolia*, *L. hirtella* (5 plants), *L. linearis* (2 clumps), *L. palustris*, and *L. sphaerocarpa*. The disappearance for almost 20 years of an occurrence of the rare perennial *Ludwigia hirtella* as a result of canopy closure at this site, and its sudden return during the past decade after a couple of hot fires leads to the speculation that this population may be from the same vicinity as the one discovered by C. F. Parker in 1867. The equally rare *Ludwigia linearis*, on the other hand, is a *de novo* occurrence just recently discovered by the leader in shallow water nearby.

On the west side of Route 206 in ditches, swales and embankments bordering the abandoned railroad right-of-way, we observed *Baccharis halimifolia*, *Cichorium intybus*, *Chondrilla juncea*, *Conyza canadensis*, *Erechtites hieracifolia*, *Gaillardia pulchella* (garden escape), *Pluchea odorata* var. *succulenta*, *Taraxacum officinale*, *Vernonia noveboracensis*, *Buddleia davidii* (garden escape), *Paulownia tomentosa*, *Plantago aristata*, *P. lanceolata*, *P. major*, *Polygonum aviculare*, *Polygala cruciata*, *Trichostema dichotomum*, *Digitaria filiformis*, *D. ischaemum*, *D. sanguinalis*, *Eragrostis capillaris*, *E. spectabilis*, *Muhlenbergia uniflora*, *Saccharum giganteum*, *Setaria faberi*, *Paspalum setaceum*, *Bulbostylis capillaris*, *Cyperus microiria*, *C. strigosus*, *Fimbristylis autumnalis*, *Anthraxon hispidus*, *Chasmanthium laxum*, *Schoenoplectus pungens*, *Juncus canadensis*, *J. marginatus*, *J. militaris*, *J. pelocarpus*, *Triadenum virginicum*, *Pogonia ophioglossoides*, *Lobelia canbyi*, *Agalinis virgata*, *Bartonia virginica*, *Pseudognaphalium obtusifolium*, *Oclemena nemoralis*, *Rhexia virginica*, *Ilex glabra*, *Chamaedaphne calyculata*, and *Lachnanthes caroliniana* .

Further south, along the road shoulder and wooded edge of the highway, we added the following species: *Solidago altissima*, *S. bicolor*, *S. erecta*, *S.fistulosa*, *S. juncea*, *S. nemoralis*, *S. odora*, *S. puberula*, *S. rugosa*, *S. sempervirens*, *S. stricta* (several dozen), *Euthamia graminifolia*, *Anaphalis margaritacea*, *Eupatorium album*, *E. hyssopifolium*, *E.perfoliatum*, *E. pilosum*, *E. rotundifolium* var. *ovatum*, *E. serotinum*, *Eurybia compacta*, *Ionactus linariifolius*, *Symphyotrichum dumosum*, *Helianthus angustifolius*, and *Juncus debilis*. This fine floral display was a result of reduction of roadside mowing.

At our lunch stop, a partially flooded excavation across the highway from the Dutchtown luncheonette, we saw a fine display of the silky plumes of *Saccharum giganteum*. In the mucky pond bottom were also *Myriophyllum* sp., *Lachnanthes caroliniana*, *Vaccinium macrocarpon*, *Utricularia juncea*, *U. purpurea*, *Juncus militaris*, *J. pelocarpus*, and *Rhexia virginica*.

Our final stop was Wescott Bogs, a string of long-abandoned cranberry bogs about 3.5 miles southeast of Dutchtown, where the goal was to study succession and see a few special plants. Periodic flooding of the site has held in check regeneration by maples and shrubs, allowing a number of herbs to compete successfully. We saw large stands of *Xyris smalliana* and the rare *Xyris fimbriata*, discovered here by the leader in the early 1970s. However, we were unable to relocate a small occurrence of the globally rare and state endangered *Eupatorium resinosum* (G3, E). Scatterd along a streamlet were a few specimens of the quite distinct pine barren Agalinis, Witmer Stone's (1911) *Gerardia racemulosa* Pennell, bearing large rose-pink (not purple) flowers and filiform, curled leaves ranging from 0.5-1.5 mm wide. The flower heads appeared to be rather large for such slender plants on their two foot tall, smooth stems. The current scientific name of this entity is quite confusing. The leader has referred it to *Agalinis* *virgata*, not to *Agalinis fasciculata*, which appears to be the current practice. The latter taxon, a far more robust plant with rough stems and much wider leaves, is a southern species that does not range to New Jersey. Growing among the *Agalinis* were two specimens of a local *Bidens* called slender-leaved tickseed sunflower that in this state is confined to swamps of the pine barrens and coastal strip. Our plants referred by Stone to *Bidens trichosperma tenuiloba* (Gray) and by Fernald to *Bidens coronata* (L.) Britton had very large flower heads and 7 linear leaf segments. Alan Weakley includes our taxon under the name *Bidens trichosperma*, and reports our entity as invalid under the name "*coronata*."

Other species observed included *Lycopodiella alopecuroides*, *Pseudolycopodiella caroliniana*, *Osmunda regalis*, *Woodwardia virginica*, *Carex striata*, *Cladium mariscoides*, *Eleocharis robbinsii*, *E. tuberculosa*, *Eriophorum virginicum*, *Rhynchospora chalarocephala*, *Schoenoplectus pungens*, *S. subterminalis*, *Pogonia ophioglossoides*, *Rubus hispidus*, *Spiraea tomentosa*, *Polygala cruciata*, *Euthamia caroliniana*, *Oclemena nemoralis*, *Lycopus* sp., *Rhexia virginica*, *Sagittaria engelmanniana*, *Triadenum virginicum*, *Drosera rotundifolia*, *Utricularia juncea*, and the typical ericaceous shrubs.

Attendance: 26. **Report by leader: Ted Gordon**

09 October (Saturday): Sourland Mountain Preserve, Somerset County, New Jersey. Joint trip with the Torrey Botanical Society.

The walk began near a small pond which was rimmed with *Eichhornia crassipes*. The adjacent wetland had such plants as *Typha latifolia*, *Polygonum sagittatum*, *Scirpus cyperinus*, and *Eupatorium perfoliatum*. *Arthraxon hispidus*, a rapidly spreading species in central New Jersey, was observed to have locally displaced *Microstegium vimineum*. We then walked uphill on an open, somewhat rocky utility line cut, to a low ridge. Plants along the way included *Helianthus giganteus*, *Solidago canadensis*, *S. gigantea*, *S. rugosa*, *Symphyotrichum lanceolatum*, *S. pilosum*, *S. racemosum*, *S. urophyllum* (*Aster sagittifolius*), and *Sorghastrum nutans*. *Bidens aristosa* was abundant along parts of the trail. Participant Michael Feder found a few plants of *Agastache nepetoides*, a Heritage-listed species in New Jersey. A young tree of *Diospyros virginiana* was thriving, as evidenced by abundant fruit and numerous seedling trees; this must be near the northern limit of this coastal plain species in New Jersey. Several participants sampled the fruit. Upon reaching the ridge, a view of the New York City skyline was observed over the intervening Watchung Ridges. After entering a woodland and following trails downhill to the parking area, we found *Solidago caesia*, *Eurybia divaricata*, and *Ageratina altissima* in bloom. Other species seen here included *Hepatica nobilis*, *Actaea* (*Cimicifuga*) *racemosa*, *A. pachypoda*, *Sanguinaria canadensis*, *Cynoglossum virginianum* (just a few leaves), *Polygonum virginianum*, *Collinsonia canadensis*, *Galium lanceolatum*, *G. circaezans*, and the ferns *Phegopteris hexagonoptera*, *Botrychium virginianum*, *Polystichum acrostichoides*, *Adiantum pedatum*, and *Athyrium filix-femina*. The weather was pleasant, and the forest was lightly touched with the colors of autumn.

Attendance: 12. **Leaders: Eleanor Saulys and Karl Anderson. Report by the latter.**

4 December (Saturday): Early Winter Botany at Delhaas Woods, Bucks County, Pennsylvania.

We botanized one of Pennsylvania's rare coastal-plains habitats, seeing wooded swamps, vernal pools, a bog, and wet and dry meadow in a powerline cut. Although the trip description promised a chance to practice identifying plants in a dormant state, in reality

the fall had been so mild that a number of plants were still in leaf. *Viburnum dentatum* (arrowwood) seemed to still have all its leaves, most of them a lovely burgundy. *Magnolia virginiana* (sweet bay magnolia), a rare plant in Pennsylvania, still had green leaves. *Malus baccata* (Siberian crabapple) still had fruit. We even saw a few flowers on a *Solidago rugosa* (rough-stemmed goldenrod) and on a *Symphyotrichum* sp. (an aster). Delhaas woods has a number of oaks; we noted *Quercus alba*, *Q. bicolor*, *Q. palustris*, *Q. phellos*, *Q. rubra*, and a possible *falcata* x *phellos* hybrid. Shrubs in the woods included abundant *Clethra alnifolia* (sweet pepperbush) and members of the heath family: *Lyonia ligustrina* (maleberry), *Eubotrys* (*Leucothoe*) *racemosa* (staggerbush), and *Vaccinium corymbosum* s.l. (highbush blueberry). In the meadows we were able to identify *Agalinis purpurea* (purple false foxglove), a *Bidens* sp. (tickseed), a *Rhexia* sp. (meadow beauty), *Sabatia angularis* (rose pink), *Eupatorium rotundifolium* and several other *Eupatorium* spp., and several *Solidago* spp. *Solidago nemoralis* (gray goldenrod) was particularly easy to identify at this time of year, because the gray hairs on the stem were quite conspicuous. For graminoids, we noted *Aristida oligosanthes*, *Calamagrostis cinnoides*, *Scirpus polyphyllus*, *Juncus dichotomus*, and the inevitable *Juncus tenuis* (path rush).
Attendance: 9. **Report by leader: Janet Novak.**

2011

12 March (Saturday): Franklin Parker Preserve, Burlington County, New Jersey. Leader: Russell Juelg. No report received.

30 April (Saturday): Hamilton -Trenton - Bordentown Marsh, Burlington County, New Jersey. Joint trip with the Torrey Botanical Society.

It was a lovely spring day for botanizing. The morning was spent at Bordentown Township's Northern Community Park and the forested Crosswicks Creek floodplain and adjacent bluff. Among the species of the field edge were *Cruciata pedemontana* and *Myosotis micrantha*, both new for the Marsh plant list, and flowering *Tradescantia virginica* and *Erodium cicutarium*. In the woods, flowering spring ephemerals included *Anemone quinquefolia*, *Arisaema triphyllum*, *Cardamine bulbosa*, *C. concatenata* (past flowering), *Claytonia virginica*, *Floerkea proserpinacoides*, *Maianthemum candense*, *M. racemosum*, *Mediola virginiana* (in bud), *Mertensia virginica*, *Podophyllum peltatum*, *Uvularia sessilifolia*, and violets (*Viola primulifolia*, *V. pubescens*, *V. sororia*). The population of *Mertensia* on the bank of Crosswicks Creek had a few white and pink individuals. Of note along the path near the bluff were *Cornus alternifolia* and a few sprouts of *Castanea dentata*.

In the afternoon, the Bordentown Bluffs provided upland woods where *Kalmia latifolia* and *Rhododendron maximum* were common understory species, and *Pinus rigida* and *Tsuga canadensis*, occasional in the canopy. Also present were *Amelanchier arborea*, *Lonicera sempervirens*, *Rhododendron periclymenoides*, as well as flowering *Vaccinium corymbosum*, *V. pallidum*, and *V. stramineum*. Herbaceous flowering / fruiting species included *Epigaea repens*, *Geranium maculatum*, and *Podophyllum peltatum*.

Thanks to Janet Novak for making her trip species list available.
Attendance: 29. **Leaders: Mary Allessio Leck and Mary Anne Borge. Report by the former.**

21 May (Saturday): Spring Sedges and Grasses of Burden Hill Forest, Alloway and Quinton Townships, Salem County, New Jersey.

Near Peck's Corner we walked across Cohansey-Pecks Corner Road onto an historic (dirt) wagon road named Old Stage Coach Road to enter an 80± acres segment of Burden Hill Forest owned by the Natural Lands Trust. Here we inspected a recently abandoned farm field occupied by common, early succession species including legumes such as *Trifolium pratense*, *T. procumbens*, *T. repens*, *Vicia grandiflora*, *V. tetrasperma*, and *V. sativa* and alien grasses such as *Aira caryophyllea*, *Bromus japonicus*, *B. sterilis*, *Dactylis glomerata*, *Festuca pratensis*, *Poa annua*, and *P. pratensis*. Among the alien dicots were *Cardamine hirsuta*, *Potentilla recta*, *Saponaria officinalis*, *Taraxacum officinale*, and *Rumex crispus*. Except for *Geranium carolinianum*, *Lepidium virginicum*, and *Oenothera laciniata*, few native annuals and biennials occupied this regenerating field in early succession.

The dry roadside bordering the old stage road constituted a distinctly separate community, the well- established open edge. This edge habitat supported some of the Burden Hill's typical upland sedges: *Carex longii*, *C. muhlenbergii*, and *C. tonsa* and drought tolerant grasses: *Dichanthelium depauperatum*, *D. ovale*, *D. sphaerocarpon*, and *Vulpia octoflora*. Abandoned > 20 years ago, another farm field east of the sand road had regenerated saplings and small canopy trees of *Sassafras albidum*, *Prunus serotina*, *Carya pallida*, and *Quercus falcata*. Woodland species here included *Crataegus uniflora*, *Castanea pumilla*, *Carex swanii*, *Opuntia humifusa*, *Lechea villosa*, *Uvularia sessilifolia*, *Polygonatum biflorum*, *Eurybia compacta* (=*Aster gracilis*), *Antennaria plantaginifolia*, *Schizachyrium scoparium*, *Oenothera laciniata*, *Dichanthelium scoparium*, and *D. clandestinum*. We continued north along the road edge into a wetland that surrounded a tributary that drained into Woodmere Lake. (Woodmere was a locally well-known cross road that was visited quite often by the late Bayard Long, curator of the herbarium at the Academy of Natural Sciences.) The tributary was forested with a canopy of *Acer rubrum* and *Nyssa sylvatica*. Scattered *Liquidambar styraciflua* and *Chamaecyparis thyoides* formed a narrow band of forest cutting through the successional fields. At the ground level of the swamp, *Symplocarpus foetidus* was dominant, growing with its typical associates, *Carex atlantica* subsp. *capillacea*, *C. foliculata*, *C. intumescens*, *Glyceria striata*, and *Bohmeria cylindrica*, a community so common in Burden Hill.

We next drove northeast approximately 3 miles to Thundergut Pond Wildlife Management Area. Here we entered a power line right-of-way north of Spillway Road where we examined an area in the vicinity of "tower #1" from which a maintenance crew had recently removed woody shrubs and tree saplings, exposing the herbaceous understory. The upland sites were composed of silty loams that supported a number of plants capable of growing in wetlands as well as uplands. *Dichanthelium scoparium*, *Juncus effusus*, and *Rubus hispidus* were examples of species with this wide latitude for soil moisture. Associated with this same habitat were *Danthonia sericea*, *D. spicata*, *Dichanthelium clandestinum*, *D. commutatum* var. *ashei*, *D. commutatum* var. *commutatum*, *D. mattamuskeetense*, *D. sphaerocarpon*, *Carex albicans* var. *emmonsii*, *C. virescens*, *Cyperus grayi*, *Eleocharis tenuis*, *Cephalanthus occidentalis*, *Eupatorium pilosum*, *Rosa palustris*, *Sparganium americanum*, and *Spiraea tomentosa*. Roadside plants included *Arabis lyrata*, *Lespedeza repens*, *Linum* sp., *Luzula multiflora*, *Lycopus virginicus*, *Melampyrum lineare*, *Sisyrinchium angustifolium*, *S. atlanticum*, *Viola brittoniana*, *V. lanceolata*, and *V.* x *primulifolia*.

The dynamic communities associated with this species-rich, high tension line, right-of-way containing several pond-like depressions has repeatedly attacted our attention on past excursions to Burden Hill Forest. Future trips, however, should begin north of "tower #2" comprised of an extensive, yet unexplored, band of shrubland that looks equally inviting. Attendance: 10. **Report by leaders: Ted Gordon and Joseph Arsenault.**

05 June (Sunday): Nottingham Serpentine Barrens, Chester County, Pennsylvania. Joint trip with members of the Consortium of the Northeastern Herbaria meeting, Academy of Natural Sciences, Philadelphia.

The Nottingham Barrens, covering about 1 square mile mostly in a Chester County park, are one of the largest remaining examples of a globally rare complex of plant communities reduced to less than 20 occurrences in the eastern United States. They are the only serpentine barrens designated by the National Park Service as a National Natural Landmark. Here the barrens consist of *Pinus rigida-Quercus stellata-Quercus marilandica-Smilax rotundifolia* (pitch pine-post oak-blackjack oak-common greenbrier) forest; grassland dominated by *Schizachyrium scoparium* (little bluestem), *Sporobolus heterolepis* (prairie dropseed), and *Sorghastrum nutans* (Indian-grass) with scattered trees; patches of thin, stony soil with a variety of rock outcrop species, including many rarities; and serpentine seeps dominated by *Deschampsia cespitosa* (tufted hairgrass). Our sightings included *Ageratina aromatica* (lesser snakeroot), *Ceanothus americanus* (New Jersey tea), *Cerastium velutinum* var. *velutinum* (barren chickweed), *Cirsium muticum* (swamp thistle), *Minuartia michauxii* (rock sandwort), *Packera anonyma* (Small's ragwort), *Phemeranthus teretifolius* (fameflower), *Phlox subulata* (moss phlox), *Sanguisorba canadensis* (Canadian burnet), *Scleria pauciflora* (few-flowered nutrush) and *Symphyotrichum depauperatum* (serpentine aster). Among the 40 native grasses living in the serpentine grasslands, species we saw in flower or fruit included *Deschampsia cespitosa*, *Dichanthelium oligosanthes* (Heller's witchgrass) and *Dichanthelium sphaerocarpon* (round-fruited rosette grass). Recognizable species that were lacking flowers included *Andropogon gerardii* (big bluestem), *Aristida dichotoma* (church-mouse three-awn), *A. purpurascens* (arrow-feather three-awn), *Schizachyrium scoparium*, *Sorghastrum nutans* and *Sporobolus heterolepis*. We examined the aftereffects of a 94-acre fire conducted three years earlier by the Natural Lands Trust's burn crew, which included expansion and renewal of the serpentine grasslands and an unexpected eruption of of *Silene antirrhina* (sleepy catchfly).
Report by leader: Roger Latham

05 June (Sunday): Longwood Gardens, Kenneth Square, Pennsylvania. Joint trip with members of the Consortium of the Norheastern Herbaria meeting, Acadamy of Natural Sciences, Philadelphia.

The group went for a behind the scene tour of the research, production, nursery, and natural areas. The Research Department has breeding programs for several different genera: *Camellia*, *Canna* and *Clivia*. They utilize tissue culture as well as traditional breeding methods to maintain disease-free cultivars and to create new cultivars. The Research Dept. also grows many other species and cultivars from around the world, testing their usefulness for display in the garden.

The main production area consists of 10 greenhouses that are controlled by a computerized system. Based on the amount of sunlight, the system will close or open vents, turn on fans, or utilize pad cooling to keep the greenhouses at optimal temperature for the specific plants inside. The production staff grows roughly 75% of the 1000-plus taxa of seasonal plants that go on display each year.

The part of the garden that is open to the public is about 250 acres, which is surrounded by as additional 800 acres that is maintained and improved. These natural areas are home to many native and several rare plants as well as a large number of birds, amphibians, reptiles, and mammals. There are many varied habitats including woods, ponds, creeks, and meadows, as well as planted areas. The Abbondi tract of land where the tour went was originally planted as a drive-through arboretum, which never came about, but which still has many different types of trees. Also on the Abbondi land is a composting facility. Manure from a local horse farm is mixed with food waste from the Terrace Restaurant and wood chips created from the trees on Longwood's property. This makes up the compost used in the outdoor plantings in the garden.

On the way to Longwood's nursery, the tour stopped at the 1.5MW solar field, installed earlier in the year. Longwood has committed to increase this to 3MW by 2018. This field will supply Longwood with 100% of its energy needs on a sunny day. Longwood's nursery grows the woody plants for display, as well as many seasonal plants in hoop houses. The staff there also grows and sculpts all of the mums for Longwood's annual *Chrysanthemum* display, including the 1000-bloom mum. The tour went in to see the massive mum which, through delicate pinching arrangement, resulted in 1339 blooms on a single plant.

Report by leader: Sara Helm Wallace

05 June (Sunday): New Jersey Pine Barrens, Atsion, Burlington County and Pleasant Mills, Atlantic County, New Jersey. Joint trip with members of the Consortium of the Northeastern Herbaria meeting, Academy of Natural Sciences, Philadelphia.

The group met at the Atsion Ranger Station. We discussed the past history of the area to document that we were in an abandoned industrial area. The iron industry and logging made major impacts on the flora here during the 18th and 19th centuries. South of Atsion, we hiked along Cherry Hill Road (aka Pyxie Road), where recent fires have occurred, to observe the flora in braided streams and drier terrestrial habitats. In a distance of less than half-a-mile we recorded over 40 species of common and rare pine barren plants including *Scirpus longii*, *Calamovilfa brevipilis*, and *Muhlenbergia torreyana*. After lunch, we hiked behind the church at Pleasant Mills (Atlantic County) to an exposed portion of Forge Pond. In this peaty wetland we recorded about 25 species, including three genera of carnivorous plants and the rare fern *Schizaea pusilla*. We expressed concern about the spread of *Chamaecyparis thyoides* into the wetland, which could cause the decline of rare herbaceous plants.

Leaders: Ernie Schuyler and Janet Novak. Report by the former.

11 June (Saturday): Columcille and Tannersville Bog, Northampton and Monroe Counties, Pennsylvania. Leaders: David Lauer and Janet Novak. No report received.

12 June (Sunday) Field Botany in the New Jersey Pine Barrens. Joint field trips with the Pinelands Preservation Alliance. See also entry for 10 July, 2010.

Other trip dates:

18 June (Saturday); 26 June (Sunday); 10 July (Sunday); 24 July (Sunday); 30 July (Saturday); 31 July (Sunday); 07 August (Sunday); 13 August (Saturday). Among the sites visited were Atsion Pitch Pine Lowlands, Chatsworth environs, Dwarf Forest in Burlington and Ocean Counties, and Hampton Furnace vicinity.

Special Pinelands Plants Course Field Trips

In June, July and August 2010 and July and August of 2011, the Pinelands Preservation Alliance conducted a series of weekly field trips to characteristic Pine Barrens locations, as part of its annual Special Pinelands Plants Course. The Philadelphia Botanical Club members were invited to attend these trips. These trips gave participants the opportunity to study virtually all of the characteristic Pine Barrens plant communities and species of vascular plants. Sites visited included Pine-Oak Upland Forests, Cedar Swamps, Pitch Pine Lowlands, Wet Savannas, Coastal Plain Intermittent Ponds, and streams and rivers. Nomenclature here follows the 1991 ed. of Gleason & Cronquist. Where the Gleason & Cronquist name is considered to be an inappropriate "lump," the taxon in question is indicated in parentheses preceded by the symbol ">".

Dominant and common species in various **Pine-Oak Upland** areas included *Pteridium aquilinum* (L.) Kuhn, *Pinus rigida* P. Mill., *Pinus echinata* P. Mill., *Sassafras albidum* (Nutt.) Nees, *Quercus marilandica* Muenchh., *Quercus ilicifolia* Wangenh., *Quercus stellata* Wangenh., *Arenaria caroliniana* Walter, *Hudsonia ericoides* L., *Gaylussacia baccata* (Wangenh.) K. Koch, *Carex pensylvanica* Lam., *Vulpia octoflora* (Walt.) Rydb., *Danthonia sericea* Nutt., *Panicum sphaerocarpon* Ell., *Schizachyrium scoparium* (Michx.) Nash var. *scoparium*, and *Smilax glauca* Walt.

Rarities seen in these habitats included *Corema conradii* (Torr.) Torr. ex Loud., *Stylosanthes biflora* (L.) B.S.P., *Stylisma pickeringii* (Torr. ex M.A. Curtis) Gray var. *pickeringii*, and *Spiranthes tuberosa* Raf.

Dominant and common species in **Cedar Swamps** and in open areas immediately adjacent to the Cedar Swamps included *Osmunda regalis* L. var. *spectabilis* (Willd.) Gray, *Osmunda cinnamomea* L. var. *cinnamomea*, *Woodwardia virginica* (L.) Sm., *Chamaecyparis thyoides* (L.) B.S.P., *Sarracenia purpurea* L., *Drosera rotundifolia* L., *Vaccinium corymbosum* L., *Vaccinium macrocarpon* Ait., *Gaylussacia frondosa* (L.) T. & G., *Gaylussacia dumosa* (Andr.) T.& G. var. *bigeloviana* Fern., *Nyssa sylvatica* Marsh., *Acer rubrum* L. (>*Acer rubrum* L. var. *trilobum* Torr. & Gray ex K. Koch), *Orontium aquaticum* L., *Eriocaulon decangulare* L. var. *decangulare*, *Eriophorum virginicum* L., *Dulichium arundinaceum* (L.) Britt., *Carex trisperma* Dewey var. *billingsii* Knight, *Carex exilis* Dewey, *Carex striata* Michx. var. *brevis* Bailey, *Carex collinsii* Nutt., *Carex folliculata* L. var. *folliculata*, *Carex bullata* Schkuhr ex Willd., *Glyceria obtusa* (Muhl.) Trin., *Panicum dichotomum* L. (>*Dichanthelium lucidum* (Ashe) R. LeBlond), *Smilax rotundifolia* L., *Pogonia ophioglossoides* (L.) Ker-Gawl., and *Calopogon tuberosus* (L.) B.S.P.

Rarities seen in these habitats included *Schizaea pusilla* Pursh, *Eupatorium resinosum* Torr. ex DC., *Juncus caesariensis* Coville, *Carex barrattii* Schwein. & Torr., *Helonias bullata* L., and *Arethusa bulbosa* L.

Dominant and common species seen in **Pitch Pine Lowlands** included *Pinus rigida* P. Mill., *Leiophyllum buxifolium* (Berg.) Ell., *Kalmia angustifolia* L., *Lyonia mariana* (L.) D. Don, *Gaylussacia frondosa* (L.) Torr. & Gray ex Torr., *Pyxidanthera barbulata* Michx., *Rubus hispidus* L., *Polygala lutea* L., *Panicum dichotomum L.*(>Dichanthelium *mattamuskeetense* (Ashe) Mohlenbr.), *Amphicarpum purshii* Kunth, and *Xerophyllum asphodeloides* (L.) Nutt.,

Rarities seen in these habitats included *Crotonopsis elliptica* Willd., *Gentiana autumnalis* L., *Lobelia canbyi* A. Gray, *Solidago stricta* Aiton, *Aristida virgata* Trin., and *Calamovilfa brevipilis* (Torr.) Scribn.

Dominant and common species in **Wet Savannas** and areas immediately adjacent to them included *Lycopodium alopecuroides* L., *Pinus rigida* P. Mill., *Chamaecyparis thyoides*

(L.) B.S.P., *Hypericum densiflorum* Pursh, *Hypericum denticulatum* Walt., *Hypericum canadense* L., *Triadenum virginicum* (L.) Raf., *Sarracenia purpurea* L., *Drosera filiformis* Raf., *Drosera intermedia* Hayne, *Viola lanceolata* L., *Rhododendron viscosum* (L.) Torr., *Chamaedaphne calyculata* (L.) Moench, *Vaccinium corymbosum* L., *Vaccinium macrocarpon* Ait., *Gaylussacia dumosa* (Andr.) T.& G. var. *bigeloviana* Fern., *Proserpinaca pectinata* Lam., *Rhexia virginica* L., *Ilex glabra* (L.) Gray, *Polygala brevifolia* Nutt., *Polygala cruciata* L., *Sabatia difformis* (L.) Druce, *Utricularia cornuta* Michx., *Utricularia juncea* Vahl, *Utricularia subulata* L., *Utricularia geminiscapa* Benj., *Utricularia fibrosa* Walter, *Lobelia canbyi* Gray, *Lobelia nuttallii* J.A. Schultes, *Aster novi-belgii* L., *Aster nemoralis* Ait., *Sagittaria engelmanniana* J.G. Sm., *Xyris smalliana* Nash, *Xyris difformis* Chapman var. *difformis*, *Xyris torta* Sm., *Eriocaulon aquaticum* (Hill) Druce, *Eriocaulon decangulare* L., *Eriocaulon compressum* Lam., *Juncus pylaei* (Laharpe) Fern. & Wieg., *Eriophorum virginicum* L., *Eleocharis tuberculosa* (Michx.) Roemer & J.A. Schultes, *Rhynchospora alba* (L.) Vahl, *Rhynchospora capitellata* (Michx.) Vahl, *Cladium mariscoides* (Muhl.) Torr., *Cyperus dentatus* Torr., *Carex livida* (Wahlenb.) Willd., *Danthonia sericea* Nutt. var. *epilis* (Scribn.) Blomq., *Panicum ensifolium* Baldw., *Panicum scabriusculum* Elliott, *Amphicarpum purshii* Kunth, *Erianthus giganteus* (Walter) Muhl., *Lophiola aurea* Ker-Gawl., *Lachnanthes caroliniana* (Lam.) Dandy, *Iris prismatica* Pursh ex Ker-Gawl., *Habenaria blephariglottis* (Willd.) Hook., *Pogonia ophioglossoides* (L.) Ker-Gawl., and *Calopogon tuberosus* (L.) B.S.P.

Rarities in these habitats included *Schizaea pusilla* Pursh, *Asclepias rubra* L., *Eupatorium resinosum* Torr. ex DC., *Sclerolepis uniflora* (Walt.) B.S.P., *Xyris fimbriata* Ell., *Juncus caesariensis* Coville, *Rhynchospora oligantha* Gray, *Rhynchospora cephalantha* A.Gray, *Rhynchospora pallida* M.A. Curtis, *Scleria reticularis* Michx. (>*Scleria muehlenbergii* Steud.), *Muhlenbergia torreyana* (Schultes) A. Hitchc., *Narthecium americanum* Ker-Gawl., *Habenaria ciliaris* (L.) R.Br., and *Habenaria cristata* (Michx.) R.Br.

Common species seen in **Coastal Plain Intermittent Ponds** and similar habitats, such as intermittently inundated borrow pits, included *Woodwardia virginica* (L.) Sm., *Nuphar variegata*, *Nymphaea odorata* Ait., *Chamaedaphne calyculata* L. Moench, *Vaccinium macrocarpon* Ait., *Myriophyllum humile* (Raf.) Morong, *Proserpinaca pectinata* Lam., *Decodon verticillatus* (L.) Ell., *Rhexia virginica* L., *Gratiola aurea* Pursh, *Utricularia geminiscapa* Benj., *Utricularia fibrosa* Walter, *Sagittaria engelmanniana* J.G. Sm., *Eriocaulon aquaticum* (Hill) Druce, *Eleocharis robbinsii* Oakes, *Eleocharis tuberculosa* (Michx.) Roemer & Schultes, *Carex striata* Michx. var. *brevis* Bailey, and *Panicum spretum* Schultes.

Rarities seen in these habitats included *Ludwigia linearis* Walter, *Rhexia aristosa* Britton, *Coreopsis rosea* Nutt., *Sagittaria teres* S. Watson, and *Rhynchospora inundata* (Oakes) Fern.

Streams, rivers, permanent impoundments, and similar aquatic systems (including the entire littoral zone) supported common species such as *Osmunda regalis* L. var. *spectabilis* (Willd.) Gray, *Osmunda cinnamomea* L. var. *cinnamomea*, *Chamaecyparis thyoides* (L.) B.S.P., *Magnolia virginiana* L., *Nuphar variegata* Durand, *Nymphaea odorata* Ait. var. *odorata*, *Brasenia schreberi* J.F. Gmel., *Hypericum densiflorum* Pursh, *Hypericum denticulatum* Walt., *Triadenum virginicum* (L.) Raf., *Sarracenia purpurea* L., *Drosera filiformis* Raf., *Drosera rotundifolia* L., *Drosera intermedia* Hayne, *Viola lanceolata* L., *Chamaedaphne calyculata* (L.) Moench, *Vaccinium corymbosum* L., *Vaccinium macrocarpon* Ait., *Lysimachia terrestris* (L.) B.S.P., *Myriophyllum humile* (Raf.) Morong, *Proserpinaca pectinata* Lam., *Acer rubrum* L. (>*Acer rubrum* L. var. *trilobum* Torr. & Gray ex K. Koch), *Oxypolis rigidior* (L.) Raf., *Utricularia inflata* Walt., *Utricularia geminiscapa* Benj., *Utricularia striata* Le Conte ex

Torrey, *Cephalanthus occidentalis* L., *Viburnum nudum* L. var. *nudum*, *Viburnum nudum* L. var. *cassinoides* (L.) Torr. & Gray, *Viburnum dentatum* L., *Aster novi-belgii* L., *Sagittaria engelmanniana* J.G. Sm., *Orontium aquaticum* L., *Peltandra virginica* (L.) Schott, *Xyris difformis* Chapman var. *difformis*, *Eriocaulon aquaticum* (Hill) Druce, *Juncus canadensis* J. Gay ex Laharpe, *Juncus militaris* Bigelow, *Scirpus subterminalis* Torr., *Scirpus cyperinus* (L.) Kunth, *Eleocharis robbinsii* Oakes, *Cyperus dentatus* Torr., *Dulichium arundinaceum* (L.) Britt., *Carex canescens* L., *Carex exilis* Dewey, *Carex striata* Michx. var. *brevis* Bailey, *Glyceria obtusa* (Muhl.) Trin., *Panicum verrucosum* Muhl., *Panicum longifolium Torr.*, *Sparganium americanum* Nutt., *Pontederia cordata* L., *Iris prismatica* Pursh ex Ker-Gawl., *Pogonia ophioglossoides* (L.) Ker-Gawl., and *Calopogon tuberosus* (L.) B.S.P. var. *tuberosus*.

Rarities seen in these habitats included *Nymphoides cordata* (Ell.) Fern., *Utricularia purpurea* Walt., *Sclerolepis uniflora* (Walt.) B.S.P., *Potamogeton confervoides* Reichenb., *Carex barrattii* Schwein. & Torr., and *Panicum scabriusculum* Elliott.

Report by Leader: **Russell Juelg**

19-23 June (Sunday to Thursday): Ithaca College and Vicinity in the Finger Lakes Region, New York. Annual Joint Field Meeting of the Northeast Section of the Botanical Society of America, the Torrey Botanical Society, and the Philadelphia Botanical Club.

This year's meeting was cosponsored with the Finger Lakes Native Plant Society and the New York Flora Association. **David Werier**, Botanical and Ecological Consultant, from Ithaca, New York, planned and led the field trips with the assistance of **Larry Klotz** and **Robynn Shannon**.

The meeting opened on Sunday evening with a lecture by **Dr. Karl Niklas**, Cornell University, on "Fossil Ferns of the Finger Lakes." On Monday the group traveled by chartered bus to Lime Hollow Center for Environment and Culture in Cortland County. Botanizing took place on the Phillips Memorial Trail to Chicago Bog, (a sphagnum bog with a floating mat dominated by *Chamaedaphne calyculata*), plus a loop including the Lehigh Valley, Fen Way, Fen Connector, and Bog Spur trails. Besides the bog, the habitats included rich to acidic mesic forests, swamps, and calcareous fens. Botanical highlights included abundant *Allium tricoccum* in flower bud, *Calamagrostis canadensis*, *Calla palustris*, *Comarum (Potentilla) palustre*, *Dryopteris cristata*, *D. goldiana*, *Dulichium arundinaceum*, *Eriophorum viridicarinatum*, *Hydrophyllum canadense*, *H. virginianum*, *Iris versicolor*, *Lysimachia thyrsiflora*, *Maianthemum stellatum*, *Ribes hirtellum*, *Toxicodendron vernix*, and at least 16 species of *Carex* including *C. canescens*, *C. flava*, *C. gracillima*, *C. hirtifolia*, *C. hitchcockiana*, *C. hystericina*, *C. interior*, *C. pallescens*, *C. pensylvanica*, *C. platyphylla*, *C. prairea*, *C. schweinitzii*, and *C. scoparia*. After lunch at the Lime Hollow Visitor Center, the group continued to Bear Swamp State Forest, in the Town of Sempronius, Cayuga County. The habitats were rich forest, swamp, and calcareous rich shrub fen near the headwaters of Bear Swamp Creek. Highlights included *Actaea rubra*, *Arisaema triphyllum* subsp. *stewardsonii*, *Carex intumescens*, *C. novae-angliae*, *C. scabrata*, *C. stipata*, *C. stricta*, *Corylus cornuta*, *Dasiphora (Potentilla) fruticosa*, *Drosera rotundifolia*, *Dryopteris clintoniana*, *D. x boottii*, *Equisetum fluviatile*, *E. sylvaticum*, *Galium labradoricum*, *Ilex mucronata*, *Larix laricina*, *Lonicera canadensis*, *L. oblongifolia*, *Myrica gale*, *Oxalis montana*, *Rhamnus alnifolia*, *Rubus canadensis*, *R. dalibarda*, *R. pubescens*, *Sanicula marilandica*, *Schizachne purpurascens*, *Viburnum lantanoides*, plus four species of orchids in bloom: *Cypripedium acaule*, *Platanthera dilatata*, *P. grandiflora*, and *P. huronensis*. A stand of the native giant reed, *Phragmites americanus*, was observed in the shrub fen. David

Werier explained the characters distinguishing it from the introduced, invasive *P. australis*. In the evening, the group carpooled to the Cornell University Campus for a tour of the L. H. Bailey Hortorium herbarium by **Dr. Anna Stalter**, plus a lecture by **Dr. Robert Dirig,** on "Liberty Hyde Bailey and 'Things of the Garden' ".

On Tuesday the group carpooled to Michigan Hollow, a few miles south of Ithaca in Danby State Forest, Tompkins County. Habitats included rich peat swamp, rich and acidic upland forest, and an extensive marsh dominated by sedges, including *Carex comosa*, *C. diandra*, *C. lacustris*, *C. utriculata*, and at least four others in that genus. The swamp was also rich in *Carex* (at least eight species, including *C. bromoides*, *C. gracilescens*, *C. laevivaginata*, *C. leptalea*, and *C. trisperma*) along with *Clintonia borealis*, *Fraxinus nigra*, *Geum rivale*, *Gymnocarpium dryopteris*, *Lilium canadense* (in flower bud), *Ribes lacustre*, *R. triste*, and luxuriant bryophytes. The upland forest included *Brachyelytrum aristosum*, *Geum urbanum* (exotic), *Milium effusum*, *Spinulum* (*Lycopodium*) *annotinum*, *Trillium erectum*, *T. grandiflorum*, *T. undulatum*, and, of course, more Carices (at least nine species, including *C. laxiculmis* var. *laxiculmis*, *C. laxiflora*, *C. leptonervia*, *C. radiata*, *C. rosea*, and *C. sparganioides*). After lunch at the Jennings Pond section of Buttermilk Falls State Park, the caravan moved to Thatcher's Pinnacles, a forested ridge crest in Danby State Forest, with an overlook of the inlet valley at the southern end of Cayuga Lake. The habitats consisted of dry upland forest on the ridge plus dense successional vegetation in the overlook clearing. Highlights included *Asclepias quadrifolia*, *Boechera* (*Arabis*) *canadensis*, *Botrychium matricariifolium*, *Bromus pubescens*, *Carex arctata*, *C. digitalis* var. *digitalis*, *C. normalis*, *C. siccata*, *C. willdenowii*, *Ceanothus americanus*, *Dichanthelium latifolium*, *D. linearifolium*, *Elymus trachycaulus*, *Juglans cinerea*, *Lilium philadelphicum* (in bloom), *Magnolia acuminata*, *Pinus resinosa*, *Piptatherum* (*Oryzopsis*) *racemosum*, *Rhus aromatica*, and *Viburnum rafinesquianum*. David Werier demonstrated how to discern species of *Crataegus* (in immature fruit), and dewberries (in *Rubus* section *Eubatus*). He discussed the current trend of again recognizing some segregates within the overly broad species concepts that have been current for many years within these two problematical taxa. He also emphasized the value of recognizing well-marked varieties in species such as *Elymus hystrix* and *Galium circaezans*. The lecture on Tuesday evening was by **Dr. Bernd Blossey,** Cornell University: "Lifting the Curtain on a New Eco-evolutionary Dance of Plants and Worms and Deer". His findings raised many questions and much discussion, which he generously entertained for some time after the lecture had formally ended.

On Wednesday the group carpooled to Taughannock Falls State Park, Tompkins County. Some participants hiked the North Rim Trail to the Falls Overlook, while others walked the gentler Gorge Trail along Taughannock Creek. The upland forest and rock outcrop along the upper trail included *Acer ginnala* (exotic), *Amelanchier amabilis*, *A. sanguinea*, *Carex aurea*, *C. blanda*, *C. cephalophora*, *C. granularis*, *C. platyphylla*, *C. rosea*, *Cornus alternifolia*, *C. rugosa*, abundant *Cynanchum rossicum* (invasive exotic), *Hylodesmum* (*Desmodium*) *glutinosum*, *Juniperus virginiana* (gnarled old trees), *Penstemon hirsutus*, *Phlox subulata*, *Physocarpus opulifolius*, *Polygala senega*, and *Staphylea trifolia*. The mesic forests, talus slopes, and creek banks along the lower trail featured *Acer spicatum*, *Campanula rotundifolia*, *Carex albursina*, *C. plantaginea*, *Deutzia scabra* (exotic), *Diervilla lonicera*, *Diplazium pycnocarpon*, *Populus deltoides*, and abundant *Spiraea japonica* (invasive exotic). During lunch, the group viewed *Butomus umbellatus*, an exotic in bloom along the creek. The afternoon was spent just south of Ithaca College in the South Hill Natural Area, which features a swamp white oak swamp, acidic upland forest, dry clearings, wet meadow, and pond. Noteworthy species included a mixture of natives and exotics: *Asclepias speciosa*, *Galium boreale*, *G. lanceolatum*, *G. palustre*, *Lathyrus pratensis*, *Lyonia ligustrina*, *Marsilea quadrifolia*, *Nymphaea odorata*, *Penstemon digitalis*, *Pinus rigida*, *Platanthera flava* var. *herbiola*, *P. lacera*, *Potamogeton natans*, *Prunus pensylvanica*, *P. pumila* var. *susquehanae* (in wire cages for protection from deer), *Quercus bicolor*, *Q. coccinea*, *Trichophorum planifolium*, *Viola subsinuata*, and at least 19 species of *Carex*, including *C. atlantica* subsp. *atlantica*, *C. baileyi*, *C. folliculata*, *C. glaucodea*, *C. hirsutella*, *C. lurida*, *C. lucorum*, *C. swanii*, *C. tenera*, *C. umbellata*, *C. vulpinoidea*. David Werier described species distinctions within the elusive section *Acrocystis* while holding his listeners' attention, a tribute to his skill and charisma as a teacher.

The group returned to Ithaca College for an excellent buffet dinner, and David gave a lecture on "The New York Flora Atlas – A History of Tracking the Distribution of Plants in New York State". The meeting concluded on Thursday morning with a fascinating tour of the Cornell University Plant Pathology Herbarium provided by **Dr. Robert Dirig and Dr. Scott LaGreca,** and some participants still had enough time to visit the Cornell Plantations.

Attendance: The 53 registrants represented eight northeastern states and 20 botanical organizations.

Leaders: **David Werier, Cochair Robin Shannon, and Chair Larry Klotz. Report by the latter.**

16 July (Saturday): The Hirst Ponds Preserve (aka Germania Ponds), Germania, Galloway Township, southeast of Egg Harbor City, Atlantic County, New Jersey.

Prior to the commencement of botanizing, the leader provided a capsuled history of the target sites, currently owned by The Nature Conservancy. It is from his botanical mentors, the late Louis E. Hand (1901-1988) and Alfred Ernie Schuyler, that the leader learned of the botanical explorations in southern New Jersey by two extraordinary, self-taught botanists, Bob (1925-1963) and Frank Hirst (1928-2009). The brothers' passion for investigating intermittent ponds not only led to the discovery of many rare and unusual plants, but it also encouraged many others to seek out and explore the sites the Hirsts had popularized. It is important to be aware that "The Hirst Ponds," of which there are two, are known by various names, a fact that has created much confusion.

While duck hunting in the winter of 1957, Frank discovered what he called **"Leipzig Avenue Pond" (later aka Barkwoods Pond),** southeast of Leipzig Avenue between Duerer Street (Route 561) and Herschel Street in a headwater branch of Clarks Mill Stream. Frank's journal entry for 16 July 1958 indicated the ca. two acres pond "had some exceptional plants, and we were delighted: *Coreopsis rosea*, . . . *Lobelia boykinii* (new state record) and a strange, narrow spiked *Panicum* grass." On 26 February 1959, Bob and Frank took their unkown *Panicum* to Bayard Long, Curator of the Herbarium at the Academy of Natural Sciences. Frank wrote, the grass "seemed equally mysterious to Mr. Long. We left it. He is going to study it and let us know what it is." It was not until 10 August 1959 that Long finally got to see Leipzig Avenue Pond and its bounty, including the rare *Panicum*. On that day, Long added *Paspalum dissectum* to the pond's rare species list. In 1961, the mistery grass was named *Panicum hirstii* by Jason Swallen; it subsequently became *Dichanthelium hirstii*, a globally rare species. Hirsts' Panicgrass and Boykin's Lobelia were the primary targets of the current fieldtrip.

"Rare/Endangered " Plant Species (I: 1978) and (II: 1979) and The Influence of Fluctuating Water Levels upon the Incidence of Rare Plant Species of southern New Jersey are important, unpublished documents prepared for the USF&WS by John B. Gallegos and

Gilbert Cavalier that pertain, in part, to these two ponds. They are probably available at the Brigantine National Wildlife Refuge headquarters.

The two small intermittent ponds that comprise the Hirst Ponds Preserve established in 1984 are buffered by at least 340 acres of fields and forests acquired over the years by The Nature Conservancy. With permission we parked at Barkwoods Kennels and hiked a path to the pond, botanizing the mesic hardwood forest bordering the open pond. In this zone we found the following trees and shrubs: *Acer rubrum*, *Castanea dentata*, *Chamaecyparis thyoides*, *Clethra alnifolia*, *Gaultheria procumbens*, *Gaylussacia frondosa*, *Ilex opaca*, *Leucothoe racemosa* (= *Eubotrys racemosa*), *Liquidambar styraciflua*, *Mitchella repens*, *Nyssa sylvatica*, *Pinus rigida*, *Platanus occidentalis*, *Quercus alba*, *Sassafras albidum*, *Smilax rotundifolia*, and *Vaccinium corymbosum*.

The edge of the pond was invaded especially by scattered maple* and gum* saplings in association with *Chamaedaphne calyculata**, *Eubotrys racemosa**, *Woodwardia virginica**, *Thelypteris palustris*, *Carex striata**, *Dichanthelium spretum**, *Leersia oryzoides**, *Panicum rigidulum* var. *pubescens* (= *P. longifolium var. longifolium**), and *Bidens* sp*.

Devoid of depressions of standing water, the interior pond bottom, moist throughout, was laden with thousands of seedlings that were just emerging after a prolonged period of flooding. Among these tiny plantlets, most barely identifiable, were *Fimbristylis autumnalis*, *Panicum verrucosum**, the Pinelands- listed *Scleria reticularis**, the rare *Ludwigia linearis**, and basal rosettes that appeared to be the rare *Dichanthelium wrightianum**, with extremely tiny spikelets. (During a revisit by the leader on 12 August, the identidy of a substantial presence of these 5 species was confirmed.) We also noted *Apocynum* sp.*, *Bidens* sp., *Coreopsis rosea**, *Drosera intermedia**, *Eleocharis microcarpa**, *E. obtusa**, *E. olivacea* var. *olivacea**, *E. robbinsii**, *E. tenuis*, *Gratiola aurea**, *Hypericum boreale**, *Juncus acuminatus**, *Lachnanthes caroliniana**, *Lindernia dubia**, *Ludwigia palustris**, *Persicaria hydropiperoides*, *Proserpinaca pectinata**, *Rhexia virginica**, *Sphagnum cuspidatum**, *Triadenum virginicum**, *Utricularia cornuta*, *U. juncea*, *U. striata*, and *Viola lanceolata*.

About ½ mile south of the Leipzig Avenue Pond, the second pond, the **"Duerer Avenue Pond" (later aka Labounsky Pond)** lay southwest of Duerer Street (Route 531), about half way between Leipzig and Mannheim Avenues in a different headwater branch of Clarks Mill Stream. On 23 July 1958, during the Hirst brothers' initial investigation of this ca. 5 acre pond flooded to "18 inches in some spots," they found among other plants five rare elements: *Lobelia boykinii*, *Nymphoides cordata*, *Lobelia canbyi*, *Habenaria cristata* (=*Platanthera cristata*), and "quite a few of the narrow *Panicum*." (The latter, of course, *Dichanthelium hirstii*.)

After a brief stop to see a few sterile clumps of the Pinelands-listed *Carex barrattii* growing along a roadside ditch (Duerer Ave.) bordering the Preserve, we explored an abandoned blueberry field and small openings undergoing succession along the northern and eastern borders of the pond. In the past ten years this site has steadily reverted to a forested shrub community. The following species were recorded: *Acer rubrum*, *Amphicarpum purshii*, *Andropogon virginicus*, *Bartonia virginica*, *Betula populifolia*, *Comptonia peregrina*, *Dendrolycopodium obscurum*, *Diospyros virginiana*, *Elaeagnus umbellata*, *Eupatorium album*, *E. hyssopifolium* var. *hyssopifolium*, *Euthamia caroliniana*, *Gaultheria procumbens*, *Gaylussacia frondosa*, *Hypericum gentianoides*, *H. hypericoides* subsp. *multicaule* (=*H. stragalum*), *Ilex glabra*, *I. opaca*, *Juncus dichotomus*, *Juniperus virginiana*, *Kalmia angustifolia*, *Krigia virginica*, *Lechea racemulosa*, *Lespedeza capitata*, *Liquidumbar styraciflua*, *Lobelia nuttallii*, *Lycopodiella alopecuroides*, *Lyonia mariana*, *Melampyrum lineare*, *Morella pensylvanica*, *Nattallanthus canadensis*, *Nyssa sylvatica*, *Panicum virgatum*, *Pinus rigida*, *Polygala lutea*, *P. nuttallii*, *Prunus serotina*, *Pteridium aquilinum*, *Quercus alba*, *Q. ilicifolia*, *Q. marilandica*, *Q. stellata*, *Q. velutina*, *Rhexia mariana*, *Rhus copallinum*, *Robinia pseudoacacia*, *Rubus cuneifolius*, *Rumex acetosella*, *Smilax glauca*, *S. rotundifolia*, *Solidago odora*, *Toxicodendron radicans* var. *radicans*, and *Vaccinium corymbosum*. Along a moist trail a short distance west of the main (northern) entrance to the pond, we searched unsuccessfully for a small occurrence of the rare *Platanthera cristata* that has turned up here on a few occasions.

We next followed a difficult pathless route into the pond from the east which allowed us to explore a hummocky swale that linked up with the more exposed axis of the main pond bottom. The leader was hoping to find the endangered *Lobelia boykinii*, specimens of which he had last seen here in the 1980s.

The present site had become dominated by *Woodwardia virginica*, *Cladium mariscoides*, *Carex striata* and *Xyris smalliana* and may no longer be suitable habitat for the *Lobelia*. **The discovery of a few culms of *Xyris fimbriata*, a new rare plant** at this swale, mixed in with the dominant *X. smalliana*, alleviated the disappointment.

Conditions on the main pond bottom were quite similar to those at the Leipzig Avenue Pond, except here there were a few gentle swales that still retained a bit of water. Water draw down had occurred just recently, and a familiar suite of seedlings already mentioned was emerging. We searched unsuccessfully for *Dichanthelium hirstii*, focusing on the northwestern third of the pond where the leader had last seen a cluster of 5 specimens on 19 July 2003. The presence of a previously known occurrence of *Paspalum dissectum* was confirmed on the revisit of 12 August; these plants were still under water during 16 July. In addition to those species marked with an asterisk (*) under Leipzig Avenue Pond, we noted on this much larger pond bottom and edge the following additions: *Amphicarpum purshii*, *Aristida* sp. *Cladium mariscoides*, *Clethra alnifolia*, *Dryopteris intermedia*, *Euthamia caroliniana* (=*E. tenuifolia*), *Iris prismatica*, *Juncus canadensis*, *J. debilis*, *J. pelocarpus* (8/12), *Lycopus virginicus*, *Paspalum* sp., *Vaccinium macrocarpon*, and *Xyris smalliana*.

Intermittent ponds are shallow basins with sandy/clayey/peaty bottoms that experience inundation for periods that vary in length depending on variable rainfall events throughout the year. These ponds are not vernal ponds, since they flood not only in spring, but during the other three seasons as well. The hardy plants that thrive here must be able to deal with stressful conditions of alternating periods of dessication and flooding. Many have resorted to "seed banking," the storing of viable seed in the soil awaiting the return of optimal conditions suitable for their regrowth. Often plants may disappear for several years before making a sudden return. In summary, the leader acknowledged at least 13 rare species that have made sporadic appearances at the Hirst Ponds since 1958{Leipzig (1); Duerer (2)}: *Coreopsis rosea*^(1,2), *Dichanthelium hirstii*, *Lobelia boykinii*, *Lobelia canbyi*, *Ludwigia linearis*^(1,2), *Nymphoides cordata*^(2), *Paspalum dissectum*^ (2), *Platanthera cristata*, *Rhynchospora inundata*, *Rhynchospora nitens*, *Sagittaria teres*, *Scleria reticularis*^ (1,2), and *Utricularia purpurea*. Of these only five were observed, while two, *Dichanthelium wrightianum*^ (1,2) and *Xyris fimbriata*^(2), were new discoveries. {^ seen on this trip}

Special thanks go to Janet Novak and Larry Klotz for their input to the species lists. Attendance: 28. **Report by leader: Ted Gordon.**

20 August (Saturday): Crow's Nest Preserve, Northwestern Chester County, Pennsylvania.

Crow's Nest is a 600 acre-plus preserve located off the southeastern corner of French Creek State Park somewhat south of Pottstown. The parcel was acquired by The Natural Lands Trust (NLT) in about the mid-1990s. A former farm, it is currently a general mixture of forest (with oak/hickory being the dominant type), creek-related habitats and marshlands, and a combination of meadows and actively plowed grasslands and croplands. Several management practices are being employed for the purpose of maintaining and enhancing native biodiversity. These measures include at least three strategies: 1) screening out and extracting of problematic invasive species, 2) conducting a yearly hunting program to hold in check a sizable deer herd from over browsing and destroying desired species, and 3) conducting at least semi-annual prescribed burns of the meadows to prevent woody species from reaching maturation and to preserve pioneer conditions for sun-loving herbs.

Our goal today was to botanize only the extreme northern tier of this vast preserve. Future visits are planned in successive years until the plants of the entire parcel have been documented. A final plant list will be provided to NLT, as per their request. In recent years Jack Holt, Janet Ebert, Ann Rhoads, Timothy Block, and others have botanized portions of Crow's Nest and maintained species lists. **Dan Barringer**, the preserve's manager for the past 15 years, has generously assisted the leader in planning this long term project, providing a series of previously developed plant lists and a very useful preserve topographical map revealing botanical "hotspots," of which partial copies were handed out to the participants.

We gathered in the preserve's barn/visitor center for an orientation meeting and then carpooled to our trip starting point, which had room for just two cars. We botanized the northern roadside and then moved into the woods. **Jack Holt**, who confirmed the identity of the diverse species that were encountered, made the group aware of the success of active deer management here. According to Jack, who has botanized the preserve on several visits, many areas still suffer from deer browsing because of inadequate management.

We next drove southward via easy access to most of the remaining sections of the northern tier. After inspecting a tree line/windbreak and then two meadows far to the west, we entered a small forest. As for the managed meadows, Jack commented that they appear to have maintained their high level of biodiversity that he had observed 10 years ago. We concluded botanizing in a small segment of an oak-hickory forest in the exteme northwestern corner of the preserve.

Species observed in the northern tier (Jack Holt):

Acalypha rhomboidea, *A. virginica*, *Acer platanoides*, *A. rubrum*, *Achillea millefolium*, *Actaea racemosa*, *Agrimonia striata*, *Agrostis gigantea*, *A. perennans*, *Ailanthus altissima*, *Alliaria petiolata*, *Ambrosia artemisiifolia*, *A. trifida*, *Amelanchier arborea*, *Amphicarpa bracteata*, *Andropogon glomeratus*, *A.virginicus*, *Anemone americana*, *Anthoxanthum odoratum*, *Apocynum cannabinum*, *Aralia nudicaulis*, *Arisaema triphyllum*, *A. triphyllum* subsp. *pusillum*, *Aronia arbutifolia*, *Asclepias purpurascens*, *A. syriaca*, *A. tuberosa*, *Athyrium filix-femina* var. *angustum*, *Barbarea vulgaris*, *Berberis thunbergii*, *Betula lenta*, *Bidens frondosa*, *B. tripartita*, *Botrypus virginianus*, *Calystegia sepium*, *C. spithamaea* subsp. *spithamaea*, *Cardamine pensylvanica*, *Carex bromoides*, *C. debilis* var. *debilis*, *C. digitalis*, *C. glaucodea*, *C. gynandra*, *C. intumescens*, *C. laxiculmis*, *C. prasina*, *C. radiata*, *Carex* spp., *C. stricta*, *C. swanii*, *Carpinus caroliniana* subsp. *virginiana*, *Carya glabra*, *C. ovata*, *C. tomentosa*, *Castanea dentata*, *Celastrus orbiculatus*, *Celtis occidentalis*, *Cerastium fontanum*, *Chelone glabra*, *Chrysosplenium americanum*, *Cinna arundinacea*, *Circaea canadensis* subsp. *canadensis*, *Cirsium discolor*, *Clematis virginiana*, *Clinopodium vulgare*, *Collinsonia canadensis*, *Commelina communis*, *Cornus alternifolia*, *C. amomum*, *C. florida*, *C. racemosa*, *Corylus americana*, *Crataegus crus-galli*, *Crataegus* sp., *Cuscuta gronovii*, *Cyperus strigosus*, *Dactylis glomerata*, *Danthonia spicata*, *Daucus carota*, *Dennstaedtia punctilobula*, *Desmodium nudiflorum*, *D. paniculatum*, *D. perplexum*, *Dichanthelium acuminatum*, *D. boscii*, *D. clandestinum*, *D. dichotomum*, *Digitaria ischaemum*, *Dioscorea villosa*, *Diospyros virginiana*, *Dryopteris carthusiana*, *Elaeagnus umbellata*, *Eleocharis olivacea*, *E. tenuis*, *Elymus hystrix*, *Endodeca serpentaria*, *Epilobium coloratum*, *Erechtites hieracifolia*, *Erigeron annuus*, *Euonymus alatus*, *Eupatorium perfoliatum*, *Eurybia divaricata*, *Euthamia graminifolia*, *Eutrochium fistulosum*, *Fagus grandifolia*, *Fallopia scandens*, *Fragaria virginiana*, *Fraxinus americana*, *Galium circaezans*, *G. mollugo*, *G. triflorum*, *Gaylussacia baccata*, *Gentiana andrewsii*, *Geranium maculatum*, *Geum canadense*, *Gleditsia triacanthos*, *Glyceria striata*, *Hemerocallis fulva*, *Hieracium paniculatum*, *Hypericum punctatum*, *Ilex opaca*, *I. verticillata*, *Impatiens capensis*, *Juglans nigra*, *Juncus acuminatus*, *J. biflorus*, *J. effusus*, *J. tenuis*, *Juniperus virginiana*, *Kalmia latifolia*, *Kummerowia striata*, *Lactuca canadensis*, *Leersia oryzoides*, *L. virginica*, *Lespedeza repens*, *Liatris spicata*, *Ligustrum obtusifolium*, *Linaria vulgaris*, *Lindera benzoin*, *Liriodendron tulipifera*, *Lobelia inflata*, *Lonicera japonica*, *L. maackii*, *Ludwigia alternifolia*, *Lycopus uniflorus*, *L. virginicus*, *Lysimachia quadrifolia*, *Maclura pomifera*, *Maianthemum canadense*, *M. racemosum*, *Medeola virginiana*, *Microstegium vimineum*, *Mitchella repens*, *Morus alba*, *Muhlenbergia schreberi*, *Nyssa sylvatica*, *Oenothera fruticosa* subsp. *glauca*, *Onoclea sensibilis*, *Osmorhiza* sp., *Osmunda cinnamomea*, *Oxalis dillenii*, *Panicum anceps*, *Parthenocissus quinquefolia*, *Paspalum laeve*, *Penstemon digitalis*, *Perilla frutescens*, *Persicaria arifolia*, *Persicaria longiseta*, *Persicaria maculosa*, *P. perfoliata*, *P. punctata*, *P. sagittata*, *P. virginica*, *Phleum pratense*, *Phryma leptostachya*, *Physalis heterophylla*, *Phytolacca americana*, *Pilea pumila*, *Pinus strobus*, *Plantago lanceolata*, *P. rugelii*, *Platanus occidentalis*, *Poa compressa*, *Polygonatum biflorum*, *P. pubescens*, *Polygonum aviculare*, *Polystichum acrostichoides*, *Potentilla canadensis*, *P. simplex*, *Prenanthes altissima*, *Prunella vulgaris*, *Prunus avium*, *P. serotina*, *P. subhirtella*, *P. virginiana*, *Pteridium aquilinum*, *Pycnanthemum tenuifolium*, *P. virginianum*, *Pyrus calleryana*, *Quercus alba*, *Q. montana*, *Q. palustris*, *Q. rubra*, *Q. velutina*, *Ranunculus recurvatus*, *Rhododendron periclymenoides*, *Rhus copallina*, *R. glabra*, *Rhynchospora capitellata*, *Rosa carolina*, *R. multiflora*, *R. palustris*, *Rubus allegheniensis*, *R. flagellaris*, *R. hispidus*, *R. occidentalis*, *R. phoenicolasius*, *Rumex obtusifolius*, *Sambucus canadensis*, *Sanguinaria canadensis*, *Sanicula canadensis*, *Sassafras albidum*, *Sceptridium dissectum*, *Schizachyrium scoparium*, *Scirpus cyperinus*, *S. georgianus*, *Scutellaria integrifolia*, *S. lateriflora*, *Sedum telephium*, *Setaria parviflora*, *Smilax glauca*, *S. herbacea*, *S. rotundifolia*, *Solanum carolinense*, *Solidago caesia*, *S. canadensis*, *S. gigantea*, *S. juncea*, *S. patula*, *S. rugosa*, *Sonchus asper*, *Sorghastrum nutans*, *Stellaria alsine*, *S. media*, *Symphyotrichum laeve* var. *laeve*, *S. lanceolatum*, *S. lateriflorum*, *S. pilosum* var. *pilosum*, *S. puniceum*, *S. undulatum*, *Symplocarpus foetidus*, *Taraxacum officinale*, *Teucrium canadense*, *Thelypteris noveboracensis*, *T. palustris*, *Toxicodendron radicans*, *Tridens flavus*, *Trifolium repens*, *Ulmus rubra*, *Uvularia perfoliata*, *Uvularia sessilifolia*, *Vaccinium corymbosum*, var. *pallidum*, *V. stamineum*, *Vernonia noveboracensis*, *Veronica americana*, *Veronica officinalis*, *V. serpyllifolia*, *Viburnum acerifolium*, *V. dentatum*, *V. prunifolium*, *Vincetoxicum nigrum*, *Viola blanda*, *V. cucullata*, *V. fimbriatula*, *V. pubescens*, *V. sororia*, *Vitis aestivalis*, *V. labrusca*, *V. vulpina*.

Thanks go to Jack Holt for maintaining an extensive species list, to Dan Barringer for assistance in planning this project, and to Ted Gordon for his generous input in organizing this report.

Attendance: 8. **Report by leader: Paul Schubert.**

10 September (Saturday): Workshop on Basic Morphology and Systematics of Flowering Plants at the Academy of Natural Sciences, Philadelphia, Pennsylvania.

The workshop was designed for those interested in plants but with little or no formal education in botany. The workshop started with a short lecture on plant systematics. It then continued with lab work that focused on distinguishing both vegetative and reproductive morphological characters. Participants had the opportunity to study freshly collected plant specimens under stereo-microscopes. The workshop also included a slide show on the most common families of flowering plants.

Attendance: 15? **Report by leader: Alina Freire-Fierro.**

18 September (Sunday): Cresheim Creek, Wissahickon Section of Fairmount Park, Philadelphia, Pennsylvania.

This trip emphasized the basics for those new to field botany, and we discussed botanical topics ranging from leaf morphology to landscape history. We walked into Fairmount Park from Cresheim Road, and then walked downstream through woods until we found an open area, where the woods had been removed by floods and construction work on a new bridge. In this site were various native trees and shrubs planted by the Friends of the Wissahickon. We walked further downstream on the Mt. Airy side of Cresheim Creek, through an area that had a paper mill in the 19th century and now is dominated by *Liriodendron tulipifera* (with oldest individuals of approximately a hundred years of age). Further downstream we went up the hill towards St. George's Road, past scattered individuals of *Fagus grandifolia*, to a rocky hilltop where we saw *Kalmia latifolia* growing under *Quercus montana*. Farther along downstream, on the same side of the stream, we noted a large stand of *Pinus strobus*; these trees were approximately one hundred years old and most likely were planted for soil erosion control. Throughout the day, we saw many alien plants, such as *Acer platanoides* (Norway maple) and *Rhodotypos scandens* (jet bead). Also in the park were some unexpected ornamental plants that were most likely planted. For example, on the Chestnut Hill side of the creek, near Gate House Lane, was one individual of *Poncirus trifoliata*, and nearby was a *Styrax ?americanus* (both near the creek).

Attendance: approximately 15. **Report by the leaders: Janet Novak and David Hewitt.**

03 December (Saturday): Winter Botany in Houston Meadows, Fairmount Park, Philadelphia, Pennsylvania.

We botanized a section of Fairmount Park that has historically remained meadow because of sandy, low-fertility soil and fire. However, after the area became part of the Fairmount Park system in 1938, fires were suppressed, and the surrounding forest increasingly encroached upon the meadows. In 2008, Fairmount Park began a restoration effort that will double the area of the meadows, bringing it close to their size in the early 20th century. On our trip, we saw areas that, one year ago, had been cleared of trees and seeded with native warm-season grasses and a few forbs. These areas are currently still dominated by weedy species such as *Brassica rapa* and *Dactylis glomerata*, but there were also quite a few native pinweeds (*Lechea* spp.). Pinweeds were not included in the seed mix, and so they probably grew from seed in the seed bank. The core areas of meadow had a diverse set of native grasses and herbs. The dominant grasses were *Andropogon virginicus*, *Schizachyrium scoparium*, and *Tridens flavus*. Among forbs, we noted three species of *Eupatorium* (sensu strictu), including the state-listed *Eupatorium rotundifolium* var. *ovatum*. Another unusual plant was *Asclepias viridiflora*. Although we saw at most 20 individual plants of this species, they seemed to be doing well; we saw multiple plants in fruit.

Also botanized was a small but beautiful oak-hickory woodland. In this area, the infertility of the soil was indicated by the sparseness of the trees and by the understory dominated by acid-loving shrubs (*Vaccinium stamineum*, *V. pallidum*). This woods also had some very large patches of a handsome moss tentatively identified as haircap moss (*Polytrichum commune*). We were pleased to see oak trees of all age classes, meaning that here, unlike in many other sections of the Park, oak was able to regenerate successfully.

The final area of note was a deer exclosure where the oak-hickory forest had been in decline and park personnel was trying to restore it. Here, the trees were denser, understory plants were lacking, and oaks were not regenerating themselves. Park personnel thinned the trees (especially aliens species and *Populus*) to encourage development of the understory, and they planted various shrubs, including *Hamamelis virginiana*, *Rhododendron periclymenoides*, *Corylus americana*, and *Viburnum dentatum*. At the edge of the oak-hickory forest were several shrubs of coralberry (*Symphoricarpos orbiculatus*) that did not appear to have been planted.

One surprise was the number of plants still in bloom: *Symphyotrichum lanceolatum*, *Pseudognaphalium obtusifolium*, a few plants of *Solidago canadensis*, and one *Vaccinium stamineum* blooming approximately seven months late.

The other plants recorded were *Acer rubrum*, *Achillea millefolium*, *Ageratina altissima*, *Ailanthus altissima*, *Antennaria* sp., *Apocynum* sp., *Aralia elata*, *Artemisia vulgaris*, *Asclepias tuberosa*, *Betula lenta*, *B. populifolia*, *Carex* sp., *Carya* sp., *Celastrus orbiculatus*, *Cerastium fontanum*, *Chamaecrista fasciculata*, *Conyza canadensis*, *Cornus florida*, *Crataegus* sp., *Desmodium* sp., *Dryopteris carthusiana*, *Elaeagnus umbellata*, *Erechtites hieraciifolia*, *Eupatorium hyssopifolium*, *E. serotinum*, *Euthamia graminifolia*, *Fagus grandifolia*, *Ilex opaca*, *Juncus tenuis*, *Juniperus virginiana*, *Lespedeza capitata*, *Liriodendron tulipifera*, *Lobelia inflata*, *Lonicera japonica*, *Malus* sp., *Microstegium vimineum*, *Miscanthus sinensis*, *Morella pensylvanica*, *Nyssa sylvatica*, *Oxalis* sp., *Paulownia tomentosa*, *Pinus strobus*, *Plantago lanceolata*, *Platanus occidentalis*, *Populus grandidentata*, *Potentilla canadensis*, *Prunus cf. pensylvanica*, *Prunus* sp., *Pteridium aquilinum*, *Quercus imbricaria*, *Q. montana*, *Q. rubra*, *Q. stellata*, *Robinia pseudoacacia*, *Rosa multiflora*, *Rubus phoenicolasius*, *Rubus* sp., *Rumex acetosella*, *Sassafras albidum*, *Setaria* sp., *Smilax glauca*, *Solanum nigrum*, *Solidago caesia*, *S. nemoralis*, *S. rugosa*, *Stellaria media*, *Trichostema dichotomum*, and *Verbascum* sp.

Thanks go to Helen McKean for recording the species list.

Attendance: 6. **Report by leader: Janet Novak.**

Bartonia No. 66: 120–121, 2013

Program of Meetings
September 2011–May 2013

Date	*Subject*	*Speaker*
2011		
22 Sept	Members' Reports on Summer Botanizing	
27 Oct	Diversity Gained, Diversity Lost: Long-Term Changes in Woody Plants in Central Park, New York City and Fairmount Park, Philadelphia	Robert Loeb
17 Nov	The Bipolar Nature of *Amelanchier* (Rosaceae)	Michael Burgess
15 Dec	What Do 200 Years of Study Have to Tell Us About Pennsylvania's Lichens?	James Lendemer
2012		
26 Jan	Orchids and Their Fungi: What Do We Know and What Do We Need to Know?	Melissa McCormick
23 Feb	Behind the Doors of the Academy of Natural Sciences Herbarium: a Botanical Treasure Trove 200 Years in the Making	Alina Freire-Fierro and Tatyana Livshultz
22 Mar	Putting Amazonian Plant Diversity in Historical, Geological, and Ecological Context	Benjamin Torke
26 Apr	1892: The First Field Trip of the Philadelphia Botanical Club to Bartram's Garden—The Formation of the Club and the Preservation of Bartram's Garden	Joel Fry
24 May	Plants Grown from Seeds Collected by Meriwether Lewis in the Herbarium of Henry Muhlenberg	Ernie Schuyler
27 Sep	Members' Reports on Summer Botanizing	
25 Oct	The Invasive *Ailanthus altissima* in Pennsylvania: a Case Study Elucidating Species Introduction, Migration, Invasion, and Growth Patterns in the Northeastern U.S.	Matthew Kasson
15 Nov	Urban Apiflora of the Mid-Atlantic	Charlie Nichols
20 Dec	Gesneriad-Hunting in China: Disappearing Mountains, White Bees, Venomous Caterpillars and Grandma's Chirita	Stephen Maciejewski
2013		
24 Jan	Tree-Ring Analysis at Jefferson's Monticello: Current Applications to Garden and Landscape History	Daniel Druckenbrod
28 Feb	Origin and Diversification of *Monnina*, a Neotropical Genus in Polygalaceae, Fabales	Alina Freire-Fierro

28 Mar	Biological Invasions from Three Perspectives	Jessica Gurevitch
25 Apr	The Schuyler Lecture in North American Botany and Botanists: Early Temperate North American Botanical Collectors, 1585-1730	James Reveal
23 May	Status of Five Critically Endangered Pennsylvania Plants	Ann Rhoads

Bartonia No. 66: 122, 2013

Bayard Long Award for Botanical Research

The Bayard Long Award funds student research on plant species found in region around Philadelphia. We invite applications for the award. Students enrolled in a degree-granting program at any post-secondary level may apply. The research project must advance our knowledge of plants that occur in the northeastern and mid-Atlantic region of the United States, especially the Philadelphia area. Specifically, the research project must include at least one plant species found in this region, although it can include additional plants not found in the region. (For example, a systematic botany project focusing on a genus with worldwide distribution but with one or more species occurring in the northeastern U.S. would be eligible.) For purposes of this award, plants are defined to include vascular and non-vascular plants, as well traditional plant-like organisms: lichens, fungi, and all groups of algae. We especially encourage applications on projects that focus on field work and/or herbarium work.

The award will generally be for $1000. The application deadline is December 15. Details on applying are available on the club's web site (www.philbotclub.org/long_award.html).

We are pleased to announce that the 2012 Bayard Long Award went to Matthew Pace, a graduate student at the University of Wisconsin. Mr. Pace's description of his research:

> I wish to express my thanks to the Philadelphia Botanical Club for supporting my research through the Bayard Long Award. I am a second year PhD student in the lab of Dr. Ken Cameron at the University of Wisconsin—Madison. My research focuses on the phylogenetic systematics, population genetics, and biogeography of *Spiranthes* (Orchidaceae). *Spiranthes* has its center of diversity in the southeastern US and is found throughout North and Central America, in addition to Africa, Asia, Australia, Europe and Oceania. As many botanists know, *Spiranthes* can be a rather troublesome genus to identify due to intra-specific morphological and reproductive variation, inter-specific morphological similarities, polyploidy, cryptic speciation, and possible hybridization. The Bayard Long Award will help support one segment of my overall research: quantification of gene flow and introgression between two common species, *Spiranthes cernua* L. and *Spiranthes odorata* (Null.) Lindl., using Restriction-site Associated DNA Next Generation Sequencing methods. Currently, many researchers and naturalists believe *S. odorata* and *S. cernua* frequently engage in unidirectional gene flow from the diploid *S. odorata* to the polyploidy *S. cernua*. However actual quantification of gene flow and introgression between these species is completely lacking. The greater Philadelphia area is one location where the species co-occur and will serve as a collection area. Herbarium specimens will also be collected for morphological work and as voucher specimens. My research will illuminate the fine scale genetic diversity and relationships between *S. cernua* and *S. odorata*. My goal is to gain a clearer understanding of the exact boundaries of these often confused species and provide population-level information useful for conservation efforts.

BARTONIA

Instructions to Authors

Types of Articles Published

Bartonia publishes peer-reviewed original research in plant ecology, plant conservation, plant systematics, and related topics. Other, nonrefereed papers include the history of botany in [illegible], significant or rare plants, biography, bibliography, history of botanical exploration, and other topics of botanical interest. Short reports of new or rare plant species appear in "Notes and News." Other items include obituaries, book reviews, and field trip reports. The focus is on the mid-Atlantic region (Pennsylvania, New Jersey, Delaware, Maryland, New York, Virginia, and West Virginia), but contributions on topics of interest to a broader readership are also welcome.

Manuscript Style

Write in simple, clear sentences. Use the active voice where possible. Avoid redundancy. The style generally conforms to the Council of Science Editors (Scientific Style and Format; CSE Style Manual).

Use 12-point Times New Roman (or similar) font, double-spaced throughout, including literature cited, table and figure captions, and tables.

Double-space all text, including tables.

Do not justify the right margin.

Arrange manuscript parts in this order:

Name, address, e-mail address, and telephone number of corresponding author
Running head (fewer than [illegible] characters)
Date of original submission or resubmission
Title of paper
Name(s) of author(s)
Institutional address(es) of author(s)
Text of paper
Abstract
Introduction
Methods
Results
Discussion (and/or Conclusions)
Literature Cited
Acknowledgements
Tables (with captions)
Figure captions

Plan for each figure in a separate file, using one of the following formats (note the resolution requirements):

EPS (or PDF): Vector drawings, without shading or [illegible] fonts
TIFF (or JPEG): Color or grayscale photographs (halftones), with a minimum of 300 dpi
TIFF (or JPEG): Bitmapped (pure black & white pixels) line drawings, with a minimum of 1200 dpi
TIFF (or JPEG): Combinations bitmapped black & white and color or grayscale, with a minimum of 600 dpi

Manuscript Submission and Review

Submission of a manuscript implies that it is not under consideration in a similar form elsewhere. Authors should electronically send the manuscript, with all tables and figures, to the Editor. Multiple-authored manuscripts should be accompanied by a letter designating the corresponding author, to whom all communications from the Editor should be addressed.

The Editor will select at least two reviewers for each manuscript and, on the basis of the reviews, decide whether to accept it for publication or return it. The Editor will return manuscripts judged to require further revision along with suggestions for revision to the corresponding author. Manuscripts not accepted for publication will be returned to the corresponding author.

Authors who have been asked to resubmit a revised manuscript should return the improved version and include a list of the changes made in response to the Editor's and reviewers' comments and suggestions.

After a manuscript's final acceptance, authors will receive page proofs with a request to check and return them within 48 hours of their receipt. At that time, authors also will receive a [illegible] and a page-cost [illegible] form [illegible] The Philadelphia Botanical Club.

Bayard Long Award for Botanical Research

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The award will generally be for $1000. The application deadline is December 15. Details on applying are available on the club's web site (www.philbotclub.org/long_award.html).

We are pleased to announce that the 2012 Bayard Long Award went to Matthew Pace, a graduate student at the University of Wisconsin. Mr. Pace's description of his research:

> I wish to express my thanks to the Philadelphia Botanical Club for supporting my research through the Bayard Long Award. I am a second year PhD student in the lab of Dr. Ken Cameron at the University of Wisconsin—Madison. My research focuses on the phylogenetic systematics, population genetics, and biogeography of *Spiranthes* (Orchidaceae). *Spiranthes* has its center of diversity in the southeastern US and is found throughout North and Central America, in addition to Africa, Asia, Australia, Europe and Oceania. As many botanists know, *Spiranthes* can be a rather troublesome genus to identify due to intra-specific morphological and reproductive variation, inter-specific morphological similarities, polyploidy, cryptic speciation, and possible hybridization. The Bayard Long Award will help support one segment of my overall research: quantification of gene flow and introgression between two common species, *Spiranthes cernua* L. and *Spiranthes odorata* (Nutt.) Lindl., using Restriction-site Associated DNA Next Generation Sequencing methods. Currently, many researchers and naturalists believe *S. odorata* and *S. cernua* frequently engage in unidirectional gene flow from the diploid *S. odorata* to the polyploidy *S. cernua*. However actual quantification of gene flow and introgression between these species is completely lacking. The greater Philadelphia area is one location where the species co-occur and will serve as a collection area. Herbarium specimens will also be collected for morphological work and as voucher specimens. My research will illuminate the fine scale genetic diversity and relationships between *S. cernua* and *S. odorata*. My goal is to gain a clearer understanding of the exact boundaries of these often confused species and provide population-level information useful for conservation efforts.

BARTONIA

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Research papers communicate original research in plant ecology, plant conservation biology, plant systematics, and related topics. Other contributed papers convey the results of studies in floristics, distribution, methods, biography, bibliography, history of botanical exploration, and other topics of botanical interest. Short reports of one or two pages appear in "News and Notes." Other items include obituaries, book reviews, and field trip reports. The focus is on the mid-Atlantic region (Pennsylvania, New Jersey, Delaware, Maryland, New York, Virginia, and West Virginia), but contributions of interest to *Bartonia* readers from farther afield are welcomed.

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Submission of a manuscript implies that it is not under consideration in a similar form elsewhere. Authors should electronically send the manuscript with all tables and figures to the Editor. Manuscripts with multiple authors should be accompanied by a clear designation of the corresponding author, to whom all communication from the Editor should be addressed.

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